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Surname, Initial(s). (2012). Title of the thesis or dissertation (Doctoral Thesis / Master's Dissertation). Johannesburg: University of Johannesburg. Available from: http://hdl.handle.net/102000/0002 (Accessed: 22 August 2017).

Communication patterns and team performance within agile software development projects

A Minor Dissertation Submitted in Partial Fulfilment of the Degree of

Master of Engineering

in

ENGINEERING MANAGEMENT

at the

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

of the

UNIVERSITY of JOHANNESBURG

by

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Date: 6 January 2021

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Declaration

I hereby declare that the minor dissertation submitted for the MASTER OF ENGINEERING IN ENGINEERING MANAGEMENT degree to the University of Johannesburg, apart from the help recognised, is my own work and has not previously been submitted to another university or institution of higher education for a degree.

Abstract

Communication is a key function of team performance, a fact that has been reiterated throughout the literature. Even with strong evidence that communication plays a vital role in determining team performance, there continues to be a lack of agreement as to precisely how communication affects the performance of agile software development (ASD) teams. This research aims to provide a rich description of ASD communication patterns and how these communication patterns enable the performance of ASD teams.

The literature review found that ASD methods, which are governed by the Agile Manifesto, are communication intensive. From this, team aspects of communication that enable the values and principles were identified. These team aspects when explored in the literature resulted in various communication patterns, some with verified links to team performance. The insights from the literature regarding the team communication aspects and performance required validation by ASD academics and practitioners. A descriptive research design was employed as the means of validating the behaviours of ASD teams with a quantitative survey being selected as the means of implementing the study. Following data analysis, the results were then interpreted, and deductions were made regarding the identified patterns. The communication and team performance patterns provide insight into the current ASD team dynamic. Some of the previously known communication patterns were rejected but most communication patterns were found to be accurate. A summary of the deductions is presented in the form of a rich description of ASD communication patterns and their enablement of team performance.

This exploratory research aims to contribute to the body of knowledge that comprehensively deals with the research topic with the intent of assisting future researchers and ASD academics and practitioners with making improvements in team performance by understanding and modifying the applicable team communication aspects.

Acknowledgements

First and foremost, I would like to express my deepest gratitude to Lord Ganesha (the remover of obstacles) through whom all things are possible. Thank you for continuously reminding me every day of my unlimited potential and for faithfully guiding me through one of my most cherished endeavours - this research.

A special thank you to my partner in life, Shouan Swartz, for keeping me sane during this time. Thank you for your undying patience, love, encouragement, and that unique charisma of yours. I am extremely grateful for your support in everything that I choose to do, including this.

My sincerest appreciation and respect are extended to my research supervisors and the power duo, Prof. Annlizé L. Marnewick and Prof. Carl Marnewick, for your invaluable guidance and unwavering support throughout this research. Your vision, professionalism, and your drive to elevate others have inspired me. It has been a pleasure and a privilege working with you both.

A heartfelt thanks to my parents, family, friends, and those in my network for your unceasing support, understanding, prayers, and tolerance during this time.

Thank you to the University of Johannesburg and all those who have been involved in the assessment and completion of this research for the opportunity to complete my degree.

Vakratunda Mahakaya Surya Koti Sama Prabha

Nirvighnam Kuru Me Deva Sarva Karyesu Sarvada.

O Lord Ganesha of the curved trunk and massive body, the one whose splendour is equal to millions of suns, please bless me so that I do not face any obstacles in my endeavours.

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List of abbreviations

4IR	4th Industrial Revolution
ASD	Agile software development
ISD	Information systems development
MRT	Media Richness Theory
MST	Media Synchronicity Theory
NPD	New product development
CMC	Computer-mediated communication

1. Chapter 1: Introduction

1.1. Introduction and background

Numerous studies indicate that achieving project success cannot be accomplished without effective communication. Discenza and Forman (2007), MacKellar (2012), and Kortum and Klunder (2017) all agree that effective and efficient communication is necessary to achieve project success. Sivasubramaniam *et al.* (2012) looked at new product development (NPD) teams and determined that the key factors driving performance included internal and external communication as well as certain team attributes. Henderson (2004) used a questionnaire to ascertain the relationship between the team manager and successful project outcomes via a communication competence scale. The study utilised both encoding (activities of communication are speech, nonverbal signs, and writing) and decoding (activities of communication are listening, reading, and perception of nonverbal signs) communication activities. The results of the study emphasise the importance of the communication-performance relationship i.e. good leadership and communication increase team performance (Henderson, 2004).

Liu and Cross's (2016) study involved creating a model for project team technical performance which was motivated by the fact that there is still no consensus regarding the definition of project team performance and the factors that contribute most strongly to team performance, despite project teams being used in organisations. One of the most interesting findings of this study was that there seems to be one universal predictor of team technical performance, that is, different aspects of team cooperation (Liu and Cross, 2016).

> "*Management support, cooperation, and communication were positively related to effectiveness; efficiency was positively related to goal clarity, cooperation, and team harmony, but negatively related to team diversity; and, innovation was positively associated with knowledge/skill and cohesion, but negatively associated with team harmony*" (Liu and Cross, 2016:1150).

From Liu and Cross's (2016) study which aimed to determine a model of project team technical performance, it is evident that communication plays a vital role in team performance, however,

the lack of agreement on how to define team performance is still an area that requires future studies. Discenza and Forman (2007) discuss the main factors contributing to project success which include, amongst other factors, good communication and the appropriate use of technology tools. Project management literature is inundated with evidence that good communication is one of the facilitators of successful project realisation. Regarding the use of technology tools, the introduction of the 4th Industrial Revolution (4IR) has warranted the need to reassess the effectiveness and appropriateness of traditional project management tools and techniques for achieving project and team success.

The relationship between team communication and its influence on performance form the basis of this research. Deriving meaningful insight into the communication patterns that exist within a team is thought to be essential in indicating which team communication patterns and tendencies contribute to team performance. The studies discussed in the proceeding paragraphs provide more detail on the research topic and forms the basis of the discussion to follow in the proceeding chapters.

MacKellar (2012) conducted a small study on a group of fifteen computer science students in which their communication activities on a project were recorded to determine emergent communication patterns within software teams. MacKellar (2012) used social network analysis to derive communication patterns which indicated that the types of communication and the designation of a communication broker are drivers for project success. The article concluded that effective communication is important between team members to enable team collaboration (MacKellar, 2012).

Uflacker and Zeier (2009) used a web-based team communication platform to investigate the communication behaviour of eleven distributed engineering design projects. The researchers expressed the difficulty associated with the management of the team process which is hindered by the challenge in observing and assessing multi-modal and distributed communication activities, especially in larger and lengthier projects (Uflacker and Zeier, 2009). The many modes of communication which may be presented in different formats present the issue of lack of common grounds to obtain information that makes requirements management difficult.

"*Requirements engineering involves collaboration among many project team members*" (Marczak and Damian, 2011:47). The collaboration depends on communication and knowledge

of activities which team members possess and therefore "*ineffective coordination with those who work on requirements dependencies may result in project failure*" (Marczak and Damian, 2011:47). The study investigated roles and communication structures within the software team. Using interviews with developers, on-site observations, and application of social network analysis, the researchers found that significant communication occurred between specific roles; there are a few team members who are critical to the information flow within a project; and that observed communication structure versus the planned communication structure differed (Marczak and Damian, 2011). These were thought to be significant findings in that they provide a basis on which to conduct improvements regarding communication strategies on future projects.

Serce *et al.* (2009) studied the impact of communication behaviours on the performance of global software teams. The researchers used the big data analytics tool, cluster analysis, to identify groups displaying similar communication patterns. Students had to communicate using online collaborative software tools that supported activities such as forums, chats, emails, and wikis. Teams were monitored according to the type of interactions they had (i.e. categorised according to one of five communication behaviours: planning, contributing, seeking input, reflection/monitoring, and social interaction), the time spent on each type of interaction, and the number of interactions. Results showed that more frequent communication did not necessarily imply increased performance; teams that spent more time on contributing interactions performed better whereas teams that spent considerably more time on planning were a part of the least successful; and, the most successful team had the highest number of social interactions (Serce *et al.*, 2009). Some of the results were contrary to traditional beliefs regarding team performance.

Software developers have expressed the desirability to recognise "*dysfunctional or underestimated communication behaviours*" at an early stage in the project life to increase project performance (Kortum and Klunder, 2017:166). The study by Kortum and Klunder (2017) is useful in terms of forecasting team communication patterns to reveal potential miscommunications during a project. The study monitored mood, meetings (type, duration, and attendance), team spirit, and interactions (channel, intensity, and with whom) using a machine-learning algorithm to create a forecasting tool to manage communication behaviour. It was concluded that "*efficient team communication is crucial for software quality and project success*" (Kortum and Klunder, 2017:170).

The mentioned studies present various useful findings regarding team communication and project performance. It is clear that team performance affects project performance, but research is varied in terms of the approaches used to ascertain conclusions regarding the studies conducted.

1.2. Research contribution

As was discussed by the various researchers, it is clear to see that "communication is key to collaboration" (MacKellar, 2012) and is, today, still a relevant topic for discussion due to the increase in project failures (Bloch *et al.*, 2013). The limitations of the existing body of knowledge regarding the specific communication patterns that enable team performance motivate the investigation of ASD communication patterns and team performance. The insights can be used to improve ASD team communication and performance.

1.3. Research problem statement

Literature is inundated with studies that have been conducted to observe team communication patterns and team performance however there is no generic description for what communication aspects improve team performance. **Therefore, identifying communication patterns within ASD teams and determining the impact of the patterns in enabling team performance is the focus of this research**.

1.4. Research questions

The main intent of this research will be answered through the following questions:

1. What are the known communication patterns within ASD teams?
2. How do the various identified communication patterns enable team performance?

1.5. Research aim

The research aim is to develop a rich description, derived from theory and validated via input from practice, of ASD communication patterns and how these communication patterns enable the performance of ASD teams.

1.6. Research approach

The research concentrates on ASD teams. The interpretation of existing literature that identifies and describes ASD project teams' communication patterns and team performance will allow a meaningful understanding of the communication-performance relationship. To determine the validity of the insights, a survey will be conducted amongst ASD academics and practitioners. This will result in deductions regarding the communication patterns and team performance of ASD teams that can be used to develop a rich description.

1.7. Research layout

The research consists of five chapters. Chapter 1 introduces the research and defines and justifies the research problem domain; Chapter 2 reviews the literature regarding the research topic; Chapter 3 discusses the research methodology used to gather information which will be used for analysis; Chapter 4 discusses the analysis and results of the research; Chapter 5 summarises the results with the outcome being the determination of the rich description of communication patterns and their enablement of ASD team performance, limitations of the research, and any recommendations for future studies.

1.8. Conclusion

Communication is a key function of team performance, a fact that has been reiterated throughout the literature. However, there is still a lack of consensus as to precisely how communication affects team performance of ASD teams. This exploratory research aims to contribute to the body of knowledge that comprehensively deals with the research topic to assist future researchers and ASD academics and practitioners with making improvements in team performance by understanding and modifying the applicable team communication aspects.

2. Chapter 2: Literature review

2.1. Introduction to agile software development

The disparity between a client's requirements and the delivered product, delays in product delivery, and dissatisfaction expressed by clients with the final product were some of the predominant frustrations experienced in the software development industry during the late 1900s (Kissflow, 2020). This, together with the inability of traditional software development models, such as the waterfall model, to keep up with continuously evolving client demands, necessitated a faster and more lightweight software development model. This resulted in the emergence of the ASD model during the late 1990s and early 2000s (Korkala and Maurer, 2014).

Organisations have the choice to employ any software development model, including creating their own model, depending on the organisation's requirements and objectives (Pikkarainen *et al.*, 2008). The traditional waterfall model requires a sequential completion of stages in a project with compliance reviews at the end of each stage. The model is predictive and requires a better upfront understanding of project requirements (Inayat and Salim, 2015) and detailed initial planning and management (Estler *et al.*, 2014). In contrast, the ASD model favours certain values that centre around individuals, the product, communication, and responsiveness. The ASD model is an iterative approach to software development and implementation that sees the development of functionality and features through multiple smaller and manageable iterations (Stoica *et al.*, 2013). The ASD model is adaptive with no detailed planning involved and is dependent on the team's ability to respond to changes. Client interaction, minimal documentation, close collaboration, and open communication (specifically informal, face-to-face communication) are typical characteristics of the ASD model (Pikkarainen *et al.*, 2008; Stoica *et al.*, 2013). There are various ASD methods that are unique in their approach but are ultimately governed by the values and principles set out in the Agile Manifesto (Pikkarainen *et al.*, 2008). The choice as to which ASD method to use is dependent on various input variables that include team size, the complexity of the project, geographical location, business strategy, engineering capabilities, and project type (Stoica *et al.*, 2013).

2.2. Communication patterns in ASD project teams

There are countless studies (Barczak *et al.*, 1991; Patrashkova-Volzdoska *et al.*, 2003; Serce *et al.*, 2009; Wasiak *et al.*, 2011; MacKellar, 2012; Inayat and Salim, 2015; Yagüe *et al.*, 2016; Shafiq and Inayat, 2017) dedicated to exploring the topic of communication in the software development sphere. Communication is defined in many ways in the literature, but all definitions generally encapsulate one key aspect: information exchange. Velentzas and Broni (2014) define communication as the activity of conveying information through the exchange of thoughts, messages, or information to create a shared understanding. Al-Ani and Edwards (2008) state that communication plays a major role in software engineering projects which consist of various activities involving many individuals. The multitude of activities coupled with team size makes the team process communication intensive. Carmel and Agarwal (2001) found communication to be a mediating factor affecting both coordination and control which are imperative in successful collaborative endeavours. González-Romá and Hernández (2014) provided that communication is an integral team process allowing for the sustainment of other team processes, such as coordination and team monitoring, and which ultimately increase performance. Pikkarainen *et al.* (2008) state that the key aspect of differentiating traditional software projects from agile projects is the significant role of communication to all stakeholders of the project.

The various ASD methods are governed by the Agile Manifesto which centres around communication. All ASD methods are governed by the four foundational values which are described further in the twelve principles of the Agile Manifesto (Kissflow, 2020). The high-level communication centricity of the values of the manifesto is as follows:

- The Agile Manifesto values individuals and interactions over processes and tools. Team interactions are enabled through communication amongst individuals (Serce et al., 2009; Pollack and Matous, 2019). Individuals, and not processes, respond to an organisation's needs. Process- and tool-driven development requires communication that is scheduled and specific and may not necessarily be the most efficient way to meet the client's evolving needs (Elby, 2016).
- The priority of working software over comprehensive documentation necessitates continuous communication to drive faster development. Frequent communication lessens the need for comprehensive documentation (Pikkarainen et al., 2008; Drury-Grogan, 2014).

- The manifesto values customer collaboration which ensures ongoing alignment with the client's needs through continuous communication (Elby, 2016). Continuous communication occurs via frequent team meetings (Hummel et al., 2013). Alignment to the client's needs is further facilitated by a leader (e.g. product owner) (Dorairaj et al., 2012) to ensure appropriate development prioritisation.
- Lastly, responding to changes instead of following a plan is documented as another important value (Kissflow, 2020). As is the case with waterfall projects, sudden changes may not be communicated on time to the entire team. This communication gap may lead to project delays (KnowledgeHut, 2019). Frequent development iterations allow for frequent communication allowing for re-prioritisation of requirements and the addition of new features (Hummel et al., 2013).

These values form the basis for the twelve principles of the manifesto which describe the ASD model in greater detail. The principles speak of customer satisfaction, welcoming change, frequent delivery, working together, having a motivated team, face-to-face communication, working software, maintaining a constant development pace, good design, simplicity, self-organising teams, and reflecting and adjusting. Examining these principles reveals aspects of communication that enable them. A summary of these aspects is provided in Table 1 alongside a description of the communication aspects and communication enablers. The reference to the values and principles for each aspect are described in **Appendix A: High-level summary of the Agile Manifesto**. Intuitively, the content of communication is an aspect that underlies all communication. The reason for sending communication governs all information exchange. Each of these aspects of communication produces communication patterns which influence some aspect of team performance.

Table 1: Communication aspects found in the Agile Manifesto

Team aspect	**Reference to Agile Manifesto**	**Description**
Leadership	P5	• Information sharing increases when leaders allow teams to take responsibility for their work. This enhances communication.

Team aspect	Reference to Agile Manifesto	Description
Medium of communication	P4, P6	• Face-to-face communication is the preferred mode of communication due to the added advantage of non-verbal cues which enhances interpretation of information. • However, technology has increased the number of ways in which humans can communicate and the need to choose the correct mix of communication media is important for communicating.
Team cognition	P1 and P4	• Effective and efficient information exchange allows for the development of shared understanding. Shared understanding enhances team cognition which allows the team to better anticipate individuals' needs at any given time.
Trust	P5	• Increased opportunities to communicate (through daily stand-ups, sprint planning, and retrospective meetings) allow for increased knowledge sharing and building common awareness which builds team cohesion resulting in increased trust within teams.
Communication content	All	• As a result of communicating via different communication media, the content of communication can be classified according to project-related or interpersonal communication.
Communication quality (i.e. communication timeliness and closed-loop communication)	P1, P2, and P9	• Managing requirements and changes are facilitated through the process of sharing information. This is dependent on communication being timeous and complete. • The reliance on the successful completion of information exchange regarding project information (e.g. requirements) is crucial in increasing team cognition.

Team aspect	Reference to Agile Manifesto	Description
Communication frequency	P1, P3, P5, P7, P9, P11, and P12	• Frequent communication allows for more opportunities for the exchange of information. • Team meetings facilitate the development process by allowing for planning the work in line with prioritised requirements, tracking progress regularly, and eliminating bottlenecks in the development process timeously, allowing for additional features to be accommodated timeously, frequent software delivery, and constantly reflecting on team performance.

2.2.1. Leadership

Marnewick and Marnewick (2020) state that using Industry 4.0 technologies has created a new way of working and managing people which has resulted in the onset of the 4IR. "*Agile as a mindset is needed to implement Industry 4.0 technologies as constant change is brought about by the introduction of these new technologies*" (Marnewick and Marnewick, 2020:318). Thus, using ASD for information systems development (ISD) nowadays is the ISD method of choice (Andrias *et al.*, 2018) because these new technologies require speed and agility from the project team (Marnewick and Marnewick, 2020). Using the agile mindset to guide software development in organisations has an impact on leadership (Romijn, 2016; Moe *et al.*, 2009).

Self-organising teams are seen as one of the requirements for successful innovative projects (Moe *et al.*, 2009). Moe *et al.* (2009) prescribe that leadership in self-organising teams should be diffused rather than centralised and argue that leadership in Scrum teams, as an example, should be distributed amongst the product owner, the scrum master, and the team. The team and team leaders share ownership where leadership is rotated to the person with the key knowledge, skills, or abilities to solve the problem at hand (Moe *et al.*, 2009). Moe *et al.* (2009) found that shared leadership is imperative in ASD where the leader's role is seen as facilitative in allowing the team to make its own decisions. Leaders who allow their teams to take responsibility for their work will see an increase in information sharing resulting in effective communication (Zulch, 2014). In this sense, the aspect of trust emerged as important for

ensuring team success where the leader is responsible for cultivating trust in the team (Moe *et al.*, 2009). The leader works on removing barriers associated with the process and ensuring alignment with customer requirements (Pikkarainen *et al.*, 2008; Moe *et al.*, 2009). This type of leadership is interchangeably referred to as servant-leadership. Marnewick and Marnewick (2020) prescribe that one of the enablers of a successful agile mindset is servant-leadership. However, there seems to be no consensus on the attributes of this leadership style.

Romijn (2016) found that the choice as to the most appropriate leadership style (i.e. person-centred or team-centred) required for a project is dependent on where the organisation sits in terms of its transition from a traditional to an agile development environment and on the team efficacy level. Newly formed teams have low levels of trust between members and require a more directive leadership style. As the team increases its cognitive ability (i.e. shared mental models) and trust between members, a more supportive leadership style is prescribed. The study by Romijn (2016) concluded that with the advent of ASD, the traditional person-centred (i.e. vertical) leadership approach is being replaced with a team-centred (i.e. horizontal, shared) leadership approach (Romijn, 2016). This requires the team to coordinate through shared mental models where trust amongst team members was found to be crucial for shared leadership to occur.

Leadership influences the success of any project including agile ISD projects (Andrias *et al.*, 2018). From the literature, it seems that there is a shift from person-centred leadership to team-centred leadership and that servant-leadership is the preferred leadership style of the leadership roles within ASD teams.

2.2.2. Medium of communication

Technology has increased the number of ways in which humans can communicate (Patrashkova-Volzdoska *et al.*, 2003) providing teams with different options for communicating. Communication medium has been identified as a driver for project success (MacKellar, 2012) and thus the optimal technological medium for encouraging efficient communication has been explored extensively in the literature (Da Silva *et al.*, 2010; Green *et al.*, 2010; MacKellar, 2012; Korkala and Maurer, 2014). "*Agile software development (ASD) insists one of the main ingredients in its success is cohesive communication attributed to collocation of the development team*" (Green *et al.*, 2010:38). However, with the increasing

globalisation of many industries and work environments, collocated teams are not always practical, economical, and/or achievable. Literature focuses on the appropriate use of asynchronous media of communication.

Two frequently referred to theoretical foundations governing the selection of a medium of communication are Media Richness Theory (MRT) and Media Synchronicity Theory (MST). Daft *et al.* (1987) produced a framework for understanding communication requirements and then matching those requirements to a specific medium's capabilities. MRT classifies media from rich to lean media, with face-to-face communication being the richest and other media being considered to be leaner, with slower feedback and reduced cues. MRT argues that richer media used by teams results in higher performance of those teams (Daft *et al.*, 1987). MST claims that media differ in terms of their ability to create a social presence as well as their ability to process information (in terms of two processes i.e. conveyance and convergence of information) and that no one medium is better than another. MST suggests that for the conveyance of information, low synchronicity media (i.e. low feedback and high parallelism) is more appropriate whereas, for convergence of information, high synchronicity media (i.e. high feedback and low parallelism) is the most appropriate (Dennis *et al.*, 2008).

Communication medium amongst a group of software engineering students was investigated. The communication media investigated were email, instant messaging, and face-to-face. It was confirmed that communication medium is a driver for team success and that the preferred medium of communication of the higher-performing teams was face-to-face communication (MacKellar, 2012) due to the added advantage of interpreting non-verbal cues (Patrashkova-Volzdoska *et al.*, 2003; Guo *et al.*, 2009). The study provides evidence supporting MRT which sees the richer communication medium being preferred and more successful. Han *et al.* (2011) conducted a similar study comparing various computer-mediated communication (CMC) (i.e. web-based audio conferencing, web-based video conferencing, and web-based synchronous text communication) with face-to-face communication. It was found that no medium of communication reined superior over the others as posited by MRT. The non-dominance of any medium is supported by MST which posits that media is utilised appropriately according to information requirements (Han *et al.*, 2011). Andres (2002) compared face-to-face and video conferencing to determine whether the social presence and media richness of the medium will have an impact on team performance. Team productivity was shown to decrease when video conferencing was used. On the other hand, face-to-face teams experienced superior team productivity emphasising the need for richer media to facilitate information exchange and

implementation. The study confirms that face-to-face communication which is higher in media richness and social presence fosters a greater sense of interaction quality (Andres, 2002). Wende *et al.* (2010) found that lean media was used more at the beginning of a project instead of rich media. In the initial project phases, tasks were characterised more by conveyance (greater need for rapid information transmission) processes and teams used less synchronous media while in the later phases, tasks were more characterised by convergence (greater need for information processing) processes and teams used more synchronous media. Conversely, Green *et al.* (2010) found that the earlier phases of a distributed software development project tend to require richer communication media and fewer communication channels than other phases and that communication media that require high synchronicity are preferable in high uncertainty periods. Guo *et al.* (2009) used a technique called the dialogue technique to compare team interactions in teams using face-to-face communication and video conferencing. The dialogue technique aims to build shared mental models of effective communication that facilitates shared understanding within the team. The dialogue technique enhanced shared understanding in both face-to-face and video conferencing teams. Given the same team task and the opportunity to build a shared understanding through the dialogue technique, teams using face-to-face communication may still outperform teams using video conferencing (Guo *et al.*, 2009).

Overall, the studies highlight the superiority of face-to-face communication and the evidence supporting the need to choose an appropriate combination of richer and less rich communication media during the entire agile development process (Green *et al.*, 2010). The dialogue technique can be used to improve the performance of teams using synchronous and asynchronous communication media.

2.2.3. Team processes

Team performance models that describe team functioning have been suggested in the literature (Sivasubramaniam *et al.*, 2012; Hummel *et al.*, 2013; Marlow *et al.*, 2017). These models identify inputs that set the team conditions, dynamic processes that affect how teams interact, and enablers that moderate the effects of the inputs and processes on the outcome (Sivasubramaniam *et al.*, 2012). Inputs into the team model include team distribution (Hummel *et al.*, 2013), team characteristics (Hummel *et al.*, 2013; Marlow *et al.*, 2017), and project characteristics (Hummel *et al.*, 2013; Marlow *et al.*, 2017). The process of communication (i.e.

frequency, content, and quality) empowers other team processes and is enabled by team cognition and trust.

Team distribution refers to the extent to which team members are physically (geographically and temporally) separated (distributed) or close to each other (collocated) (Hummel *et al.*, 2013). ASD insists that one of the main requirements for its success is cohesive communication resulting from collocation (Green *et al.*, 2010). Mishra *et al.* (2012) found that collocated teams communicate more efficiently due to being in close physical proximity. But distributed teams have found the communication intensive nature of ASD to be valuable in combatting challenges that arise from distributed teamwork (Paasivaara *et al.*, 2008). Collocated teams prefer using the face-to-face medium of communication (Van Den Bulte and Moenaert, 1998; Kahn and McDonough, 2003) whereas distributed teams seem to use mainly email for communication (Patrashkova-Volzdoska *et al.*, 2003). Yagüe *et al.* (2016) found that irrespective of team distribution, communication media that encouraged team members to create closeness improved communication amongst team members. Furthermore, media appropriateness over a project's lifecycle seems to be vital for communication (Green *et al.*, 2010; Fernando *et al.*, 2011).

Inputs into the team model influence how and when team members will communicate. Team characteristics, such as team diversity and team size, and project type, may facilitate or inhibit the communication process (Marlow *et al.*, 2017). Team diversity which is present in the form of differences in culture, language, knowledge, and backgrounds is associated with a lack of common understanding. The lack of common understanding seems to be due to difficulties in communicating, particularly regarding communication quality and frequency (Marlow *et al.*, 2017) i.e. more diverse teams communicate less which provides fewer opportunities for clarification of misunderstandings and building a common understanding (Marlow *et al.*, 2017). Team size is closely related to the findings for distributed teams in that large teams tend to be distributed whereas smaller teams are collocated. Communication tends to be easier for smaller teams. Collaboration becomes more difficult as the size of the team grows (Hummel *et al.*, 2013). Like distributed teams, larger teams, in particular, have to choose their medium of communication wisely, failing which, the communication process may be hindered (Pikkarainen *et al.*, 2008). A combination of appropriate synchronous and asynchronous communication media is required especially for larger projects to maintain the team's social network (Sarker and Sarker, 2009).

Hummel *et al.* (2013) discuss the project type which refers to different project characteristics such as whether the software or application is an enhancement on an already existing one or a completely new one altogether (e.g. research and development and NPD projects); whether it is a non-critical or mission-critical application or system; or whether it is for commercial release or internal organisation use (Ågerfalk *et al.*, 2009). There is a lack of information concerning how project type affects communication in ASD (Hummel *et al.*, 2013). Hummel *et al.* (2013) found that (1) communication frequency was important for mission-critical software projects and that face-to-face communication was preferable (Cao and Ramesh, 2008) and that (2) using only oral communication (i.e. includes any type of oral communication including face-to-face and virtual/online verbal communication) may be problematic later on in maintenance projects due to lack of documentation regarding implemented system changes (Hummel *et al.*, 2013).

Team cognition and trust have been found to enable the communication process (Espevik *et al.*, 2006; He *et al.*, 2007). Team cognition encompasses the shared mental models of all individuals in a team that facilitate the achievement of tasks by acting as a coordinated unit (Walsh, 1995; Espinosa *et al.*, 2007). Team diversity provides a foundation for the establishment of cognitive structures in the team which enables information processing (Espevik *et al.*, 2006; He *et al.*, 2007) and allows teams to anticipate required information rather than request it (Butchibabu *et al.*, 2016). The transfer of knowledge from an individual's knowledge to shared team knowledge (He *et al.*, 2007) via team interaction leads to maturity of team cognition which results in increased team performance (Liang *et al.*, 1995; Moreland and Myaskovsky, 2000; Lewis, 2004).

The emergence of ASD teams has increased the importance of trust due to the flexibility team members have in setting and executing tasks autonomously (McHugh *et al.*, 2012). The role of effective communication in building trust in ASD teams is highlighted in the literature (Bhalerao and Ingle, 2010; Chan and Ying, 2014; Chagas *et al.*, 2015). Trust is considered a core value for implementing ASD methods (Meier *et al.*, 2016). "*An environment where stakeholders trust and respect each other is both a prerequisite for and a consequence of using agile methods*" (McHugh *et al.*, 2012: 71). Practices such as collective code ownership and pair programming require trust among developers, while other agile practices such as daily stand-ups, sprint planning, and retrospective meetings assist with building trust (McHugh *et al.*, 2012). McHugh *et al.* (2012) found that ASD methods increased trust by increasing communication, knowledge sharing, and feedback. The requirement by ASD methods to

practice constant interaction and frequent communication was determined to be a key factor in developing trust. In particular, the daily stand-up meetings allowed for the building of common awareness of tasks and team cohesion which resulted in the maturity of trust (McHugh *et al.*, 2012). The increased opportunities for sharing knowledge and receiving feedback also contributed to building trust (McHugh *et al.*, 2012).

2.2.4. Communication

2.2.4.1. Communication content

Communication content covers project-related communication and communication of an interpersonal nature. Few studies have evaluated the impact of communication content on team outcomes (Marlow *et al.*, 2017), and studies on communication content are scattered. The study by Wasiak *et al.* (2011) aimed to inspect and classify the content and purpose of sending emails. The use of emails for coordinating routine tasks was confirmed as it was found that most email discussions were related to the project and not the product. Information sharing was the dominant reason for sending emails which further reiterates the use of email to coordinate project-related matters (Wasiak *et al.*, 2011). In a related study, Serce *et al.* (2009) investigated the impact of different types of an individual's communication behaviour on the performance of global software teams by monitoring asynchronous communication. Five categories of collaborative behaviour, covering project-related and interpersonal content, were identified. The project-related content was planning, contributing, seeking input, and reflection/monitoring. Interpersonal communication content was identified as social interaction. Over-planning seemed to have a negative impact on team performance. A considerable amount of time spent on contributing and reflection/monitoring behaviour was associated with increased team performance. Last of all, a high amount of social interaction balanced by a proportionally greater amount of contributing behaviour resulted in higher performance (Serce *et al.*, 2009). From the few studies dealing with communication content, it is clear that there are no generalisable patterns. It seems that a combination of project-related and interpersonal communication leads to increased project performance and that email is used as a coordinating tool to share project-related information.

2.2.4.2. Communication quality

Communication quality refers to the degree to which information is accurately conveyed and understood. Marlow *et al.* (2017) emphasise the role of communication quality over the frequency of communication in the understanding of teams and argue that regardless of the frequency of communication, the quality of communication contributes to the development of shared understanding within the team. Shared understanding eventually leads to shared team cognition (He *et al.*, 2007) which allows for the individuals to work interdependently on tasks. There are two measurements of communication quality and these are communication timeliness (Marlow *et al.*, 2017) and closed-loop communication (Dingsøyr and Lindsjørn, 2013; Marlow *et al.*, 2017).

Communication timeliness refers to communication without delay. Hollingshead (1996) and Cappel and Windsor (2000) found that CMC suppressed information exchange which leads to teams taking longer to complete tasks due to having to split their time between finishing various tasks and engaging in asynchronous team interactions (Marlow *et al.*, 2017). The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of CMC increases (Marlow *et al.*, 2017). Besides the effect of communication medium on communication timeliness, the meetings-flow approach (teamwork aided through meetings) was used to guide collaborative development (Chen *et al.*, 2014) of software and was found to significantly improve the timeliness of communication and information exchange within teams which resulted in higher team cognition (Chen *et al.*, 2014).

Closed-loop communication is important in ensuring communication quality (Dingsøyr and Lindsjørn, 2013) and describes the process of a message which was sent being received and clearly understood. Closed-loop communication avoids misunderstandings that may arise due to aspects of team diversity and location (Bandow, 2001; Cramton, 2001; Korkala and Maurer, 2014). Lower-performing software engineering teams report a higher number of communication events with unsuccessful outcomes (including no response received) whilst requests for information in higher performing teams always resulted in positive interactions which continuously furthered the project (MacKellar, 2012; Engome Tchupo *et al.*, 2020). Closed-loop communication allows more opportunities for information exchange and clarification which contributes to improved shared understanding (Marlow *et al.*, 2017).

Figure 1 summarises the aspects of communication quality which is measured through communication timeliness and closed-loop communication. Communication timeliness has a higher influence as virtuality of the communication medium increases due to the asynchronicity of CMC which may suppress information exchange. Closed-loop communication allows for increased opportunities for information exchange which improves team cognition.

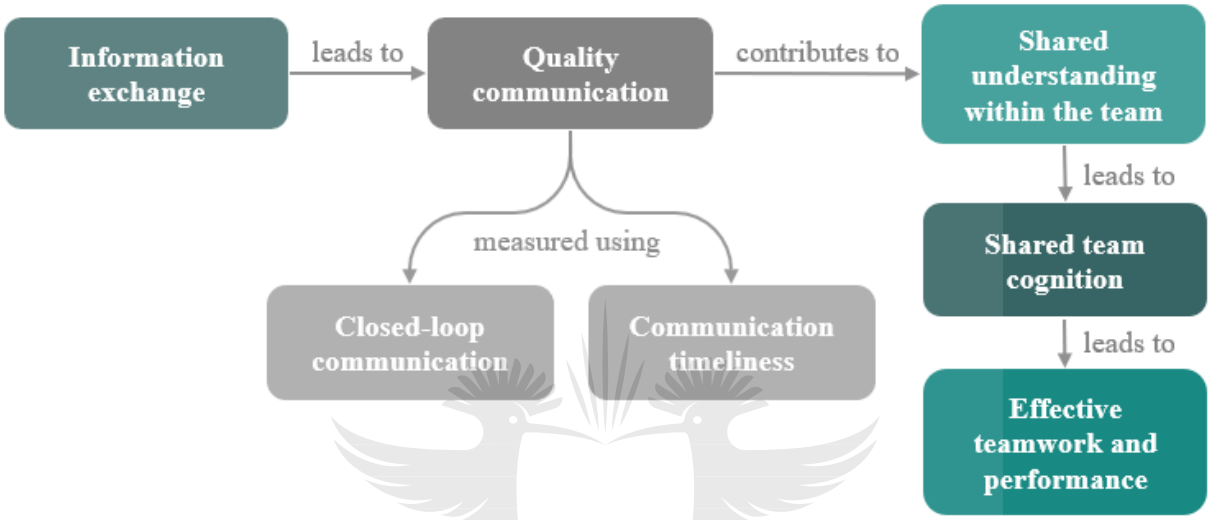

Figure 1: Aspects of communication quality

2.2.4.3. Communication frequency

Frequent communication enables both conveyance and convergence of information; two essential information exchange processes (Espinosa *et al.*, 2015). Information sharing in teams increase with communication frequency (Hinds and Mortensen, 2005). Increased communication frequency allows for an increased number of interactions which creates more opportunities for team members to contribute to shared understanding, enhancing team cognition, and coordination of activities (Weisband, 2002) which increases team functioning (He *et al.*, 2007).

He *et al.* (2007) found that the frequency of email communication did not affect team cognition or team performance whereas telephone calls and face-to-face meetings were positively associated with team cognition (He *et al.*, 2007) over time but not performance. DeSanctis and Monge (2006) and Schultze and Vandenbosch (1998) found that the frequency of communication increases with the use of CMC. As a result, increased frequency leads to

reduced efficiency. The reduced efficiency can be explained by information overload (Miller, 1956). Individuals have a limited capacity of working memory and can only process a certain amount of new information (Sweller *et al.*, 1998) implying that a greater amount of information requires more time to process the relevancy and priority of information (DeSanctis and Monge, 2006). Thus, a higher frequency in team communication does not necessarily imply increased team performance (Marks *et al.*, 2000; Patrashkova-Volzdoska *et al.*, 2003; DeSanctis and Monge, 2006). Conversely, lower communication frequencies may not supply enough information required for effective team performance (Patrashkova-Volzdoska *et al.*, 2003). The study by Patrashkova-Volzdoska *et al.* (2003) confirmed the curvilinear relationship between communication frequency and team performance where moderate communication frequency corresponds to higher performance for email and face-to-face communication but not telephone communication.

Communication frequency increases due to compulsory meetings and the subsequent encouragement of communication after meetings (Paasivaara *et al.*, 2009). Team meetings (i.e. sprint planning, standup meetings, demo meeting, and retrospective meetings) facilitate the development process by allowing for the planning of work in line with prioritised requirements, tracking progress regularly, and eliminating bottlenecks in the development process timeously (Hummel et al., 2013). Facilitation of the development process allows additional features to be accommodated timeously, allows for frequent software delivery, and continuous reflection on team performance (Serce et al., 2009). Meetings are conducted regularly where shorter iterations (Stoica et al., 2013) are encouraged to ensure that software is being developed efficiently. Frequent communication allows for the early and continuous delivery of software by providing more opportunities for the exchange of information (Patrashkova-Volzdoska *et al.*, 2003; Espinosa *et al.*, 2015). Furthermore, it was found that opportunities for increased informal communication reduced the need for documentation which in turn enhanced the software development process (Pikkarainen *et al.*, 2008).

Communication frequency facilitates information sharing which may increase team cognition and performance. As virtuality increases, the frequency of CMC increases which may cause information overload and reduced performance. The literature finds a lack of consensus on the effect of communication frequency on performance, however, there is evidence indicating a curvilinear relationship between communication frequency and team performance.

2.3. Team performance

The success of ASD projects depends on various measures of tangible results that reflect project performance (Jitpaiboon *et al.*, 2019). These can include budget, quality, and time of project delivery (Green *et al.*, 2010; MacKellar, 2012; Sivasubramaniam *et al.*, 2012), amongst others. Team performance is measured by the alignment of team dynamics (Raidén and Dainty, 2006) and team members' performance (Porter and Lilly, 1996). Findings regarding team performance suggest centricity around behavioural and social sciences (Fagerholm *et al.*, 2015) but there seems to be no specific standard measurement of team performance yet (Liu and Cross, 2016). Sudhakar *et al.* (2011) classify factors influencing team performance into four categories: (1) technical factors (include project-specific traits), (2) organisational factors (include culture, climate, structure, and values), (3) environmental factors (include customer and competition characteristics), and (4) soft factors. The soft factors can be viewed from an individual or team level. The study by Madlock (2008) determined that a manager's communication competency can strongly influence an individual's performance (i.e. employee's job satisfaction and communication satisfaction). On a team level, some of the soft factors identified by Sudhakar *et al.* (2011) include team cohesion, trust, group structure and communication, knowledge sharing, team relationships, diversity, leadership, and coordination processes. Various researchers measure team performance based on some of these soft factors. Henderson (2004) measured a manager's ability to perform encoding and decoding communication processes on the team's productivity and team satisfaction where it was found that managers can influence team performance using these processes. Chen *et al.* (2014) measured team quality as a combination of communication, coordination, mutual support, member contributions, cohesion, and effort. Han *et al.* (2011) measured team development behaviours (which included cohesiveness, conflict management, and communication), process satisfaction, team creativity, and team decision quality. Similarly, Guo *et al.* (2009) use team cohesion, communication satisfaction, team decision-process satisfaction, decision satisfaction, and decision quality to measure team performance, and Andres (2002) uses team productivity, interaction quality, and process satisfaction to measure team performance. The key findings regarding measures of team performance are summarised in Table 2. Overall, communication-related criteria and team cohesion seem to be the most acceptable means of measuring team performance followed by team productivity, team member satisfaction, process satisfaction, and decision-related criteria.

Table 2: Agile software development measures of performance

Team performance success criteria	**Authors**
Communication-related criteria	(Madlock, 2008); (Chen et al., 2014); (Guo et al., 2009); (Han et al., 2011)
Team cohesion	(Chen et al., 2014); (Han et al., 2011); (Guo et al., 2009)
Team productivity	(Henderson, 2004); (Andres, 2002)
Team member satisfaction	(Henderson, 2004); (Chen et al., 2014)
Team process satisfaction	(Han et al., 2011); (Andres, 2002)
Decision-related criteria	(Han et al., 2011); (Guo et al., 2009)
Coordination	(Chen et al., 2014)
Mutual support	(Chen et al., 2014)
Effort	(Chen et al., 2014)
Conflict management	(Han et al., 2011)
Team creativity	(Han et al., 2011)
Interaction quality	(Andres, 2002)
Employee job satisfaction	(Madlock, 2008)

2.4. Summary of findings

Table 3 provides a summary of the communication patterns in ASD teams and Figure 2 provides a summary of the input, process, and outputs of the team performance model.

Table 3: Summary of main findings from the literature concerning ASD communication patterns and enablement of performance

Category	**Main findings**
Leadership	• There is a shift from person-centred leadership to team-centred leadership. • Servant leadership is the preferred leadership style for ASD teams.

Category		Main findings
		• There seems to be an increase in information sharing within the team initiated by leaders that allow teams to take responsibility for their work.
Medium of communication		• Medium of communication is a possible driver for team success. • Face-to-face communication is the preferred medium for communication and results in increased team performance. • There is evidence supporting the need to choose appropriate media for communication during the ASD project lifecycle. • The dialogue technique can be used to improve team performance for teams using both synchronous and asynchronous communication media.
Team processes	**Team distribution**	• Collocated teams communicate more efficiently. • Collocated teams prefer face-to-face communication whereas distributed teams prefer email communication. • Irrespective of team distribution, communication media that encourages closeness improves team communication.
	Team characteristics (i.e. team diversity and team size)	• Diverse teams experience difficulties communicating (especially regarding communication quality and frequency) which results in a lack of common understanding. • Team size may hinder communication and collaboration in teams. • Communication media appropriateness increases in importance with the size of the team.
	Project type	• In general, there is a lack of information on how project types affect the communication process.

Category		Main findings
Team processes continued	**Project type continued**	• Communication frequency and face-to-face communication are possible drivers for success in mission-critical projects. • Using only oral communication may be problematic later on in maintenance projects due to a lack of documentation regarding implemented system changes.
	Team cognition	• Transfer of knowledge from an individual to the team (i.e. shared understanding) leads to increased team cognition which results in increased team performance.
	Trust	• Increasing communication frequency, knowledge sharing, and feedback increase common awareness and team cohesion which results in the maturity of trust in ASD teams.
Communication	**Content**	No generalisable patterns regarding communication content, however, the following was noted: • Email is preferred over face-to-face communication to coordinate routine tasks. • ASD team collaborative behavioural patterns.
	Quality (i.e. communication timeliness and closed-loop communication)	• The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of CMC increases. • Closed-loop communication allows more opportunities for information exchange and clarification which improves shared understanding.
	Frequency	• Communication frequency facilitates information sharing which may increase team cognition and team performance. • Possibility of a curvilinear relationship between frequency and team performance.

Category	Main findings
Team performance	• Communication and team cohesion seem to be the most acceptable means of measuring team performance, followed by team productivity, team member satisfaction, process satisfaction, and decision-related criteria.

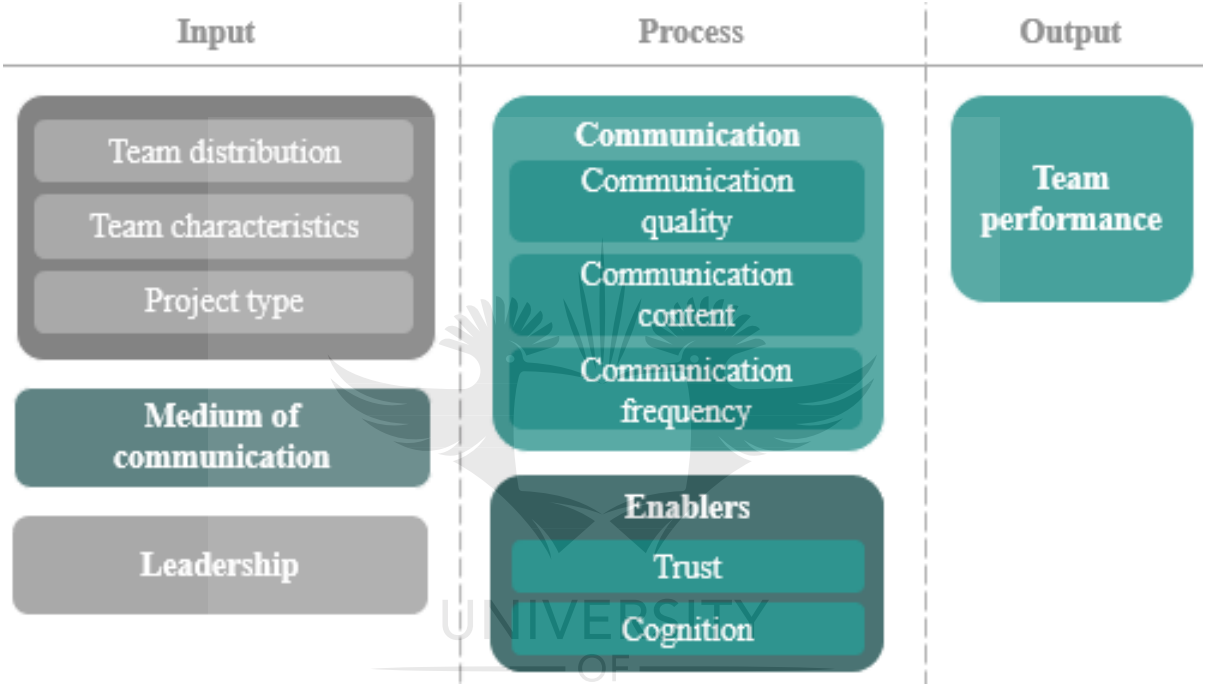

Figure 2: Impact of communication on team performance

2.5. Conclusion

The Agile Manifesto governs ASD models which are centred around communication. The communication intensive nature of the ASD model is highlighted by identifying the communication aspects that enable the ASD team aspects. The chapter presents existing insights into the identified team aspects in terms of generalisable communication patterns within ASD teams. Furthermore, the effect of communication on team performance is highlighted.

It is clear from the literature that communication is an integral team process that in some way influences performance, directly or indirectly. The measurement of team performance varies widely as can be seen from literature. However, assessing communication and team cohesion appears to be the most acceptable means of measuring team performance. It is evident that team performance is affected by certain input (i.e. team distribution, team characteristics, project type, medium of communication, and leadership) and process (i.e. communication, trust, and cognition) aspects. The communication patterns related to these input and process aspects are varied and still not well understood. Therefore, there is a lack of consensus on the recipe for exploiting communication to achieve increased team performance. The lack of consensus on the topic warrants further investigation. The insights gained from further exploratory research could prove to be invaluable in providing future researchers and ASD academics and practitoners with a basis for conducting detailed descriptive and explanatory studies regarding improving the communication process and team performance in ASD teams. The benefit to organisations that make use of ASD methods could be realised through faster software development and enhanced client satisfaction due to effective communication and increased team performance.

3. Chapter 3: Research methodology

3.1. Introduction

Communication was demonstrated to be an underlying theme of the Agile Manifesto. Communication was investigated through a thorough review of the relevant literature which identified various communication patterns and team performance measures in ASD teams. These insights require validation by ASD academics and practitioners. Chapter 3 explains in detail how the validation of these insights was achieved. Firstly, the research methodology is explained followed by the chosen research instrument. The means of handling the data are discussed through explanations of the method used for data collection and how the results were analysed and presented. Finally, the consideration of ethics and quality throughout the research design will be addressed.

3.2. Research methodology

The research aim is to develop a rich description of communication patterns and how these communication patterns enable the performance of ASD teams. Chapter 2 commenced by demonstrating how the Agile Manifesto's values and principles centre around communication. The centricity of the manifesto around communication resulted in identifying specific aspects of communication that enable the values and principles. When examined in more detail, the aspects of communication revealed unique communication patterns that, in some instances, influence certain aspects of team performance. The communication aspects identified were leadership, the medium of communication, team processes (including team distribution, team characteristics, project type, team cognition, and trust), and measures of communication (including content, quality, and frequency). The communication patterns and team performance measures identified in the literature required validation by ASD academics and practitioners.

Descriptive research aims to accurately describe a population, situation, or phenomenon (Saunders et al., 2009; McCombes, 2019). Furthermore, descriptive research is an appropriate choice when the research aims to identify characteristics, behaviours, frequencies, trends, and categories (McCombes, 2019) of the population being studied. The communication patterns represent various descriptions of behaviours of a population i.e. the behaviours being related to

communication aspects and team performance and the population being ASD teams. Naturally, this research employed a descriptive research design to verify the descriptive communication patterns and team performance measures of ASD teams derived from the literature.

To address the research questions and satisfy the aim of the research, a quantitative survey was chosen. McCombes (2019) explains that quantitative research is most applicable for measuring, ranking, categorising, identifying patterns, and making generalisations. Additionally, Armato (2017) states that quantitative research helps you measure the behaviour, opinions, and attitudes of a population by generating quantifiable data that can be transformed into statistics. The deductive nature of this research allowed for the collection of data (in the form of behaviour, attitudes, opinions, and making generalisations) regarding communication patterns and team performance measures in ASD teams. This enabled validation of the identified patterns and the ability to confirm the generalisability of the patterns within the targeted population.

The use of a cross-sectional survey approach was chosen. Survey was chosen because it allows for the gathering of large volumes of data that can be analysed for frequencies, patterns, and averages (McCombes, 2019). Survey is also suitable for soliciting information on specific topics (GutCheck, 2020). A systematic approach was followed whilst developing the survey to ensure adherence and execution of the survey method according to prescribed best practice procedures. The systematic approach had been derived from the literature (Czaja and Blair, 2011; Marnewick *et al.*, 2014) and is illustrated in Figure 3 and described in greater detail in Table 4.

To attain quantifiable data, a structured questionnaire (with closed-ended questions) was chosen as the research method. The web-based survey administrative app, SurveyMonkey, was used to conduct the questionnaire. This survey type and instrument was chosen for many reasons. The use of the web-based questionnaire can produce the required quantifiable data (collection and processing of data) cost-effectively and timeously (Benfield and Szlemko, 2006; Czaja and Blair, 2011; Rose et al., 2014). Benfield and Szlemko (2006) state that the self-administrative nature of web-based surveys lower costs as personal interviewers are not required. Nardi (2018) states that self-administered surveys are efficient for sampling larger populations in short periods. Web-based surveys allow participants the convenience of responding at a time convenient for themselves and allow the researcher instantaneous access to the data (Benfield and Szlemko, 2006). Furthermore, the likelihood of influencing the participants' responses is

reduced with self-administered questionnaires when compared with face-to-face interviews. This results in increased reliability of the results (Nardi, 2018). Using a web-based self-administered survey also allows more control over the order in which participants answer the questions (Benfield and Szlemko, 2006).

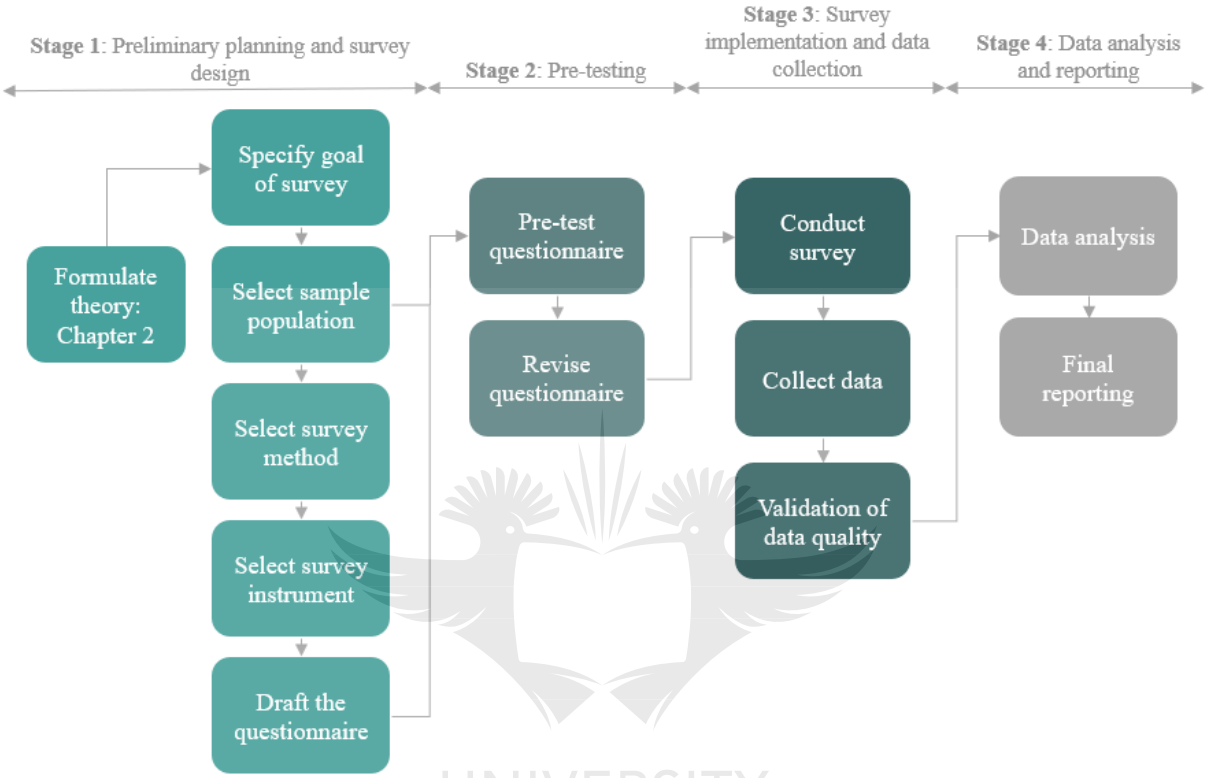

Figure 3: Survey process (Czaja and Blair, 2011; Marnewick et al., 2014)

Table 4: Description of the survey process

No.	Stage of survey	Best practice process	Execution of process
1.	**Preliminary planning and survey design**	Formulate theory (Nardi, 2018).	Insights from the literature were recorded.
		Use the research problem and questions to specify the goal of the survey (Gray, 2014; Czaja and Blair, 2011).	The goal of the survey was to produce quantitative descriptions of the communication patterns and team performance measures in ASD teams.

No.	Stage of survey	Best practice process	Execution of process
		Selection of sample population (Czaja and Blair, 2011; Marnewick *et al.*, 2014).	The target population was ASD academics and practitioners within South Africa. The target population was classified as hard-to-reach and the use of snowball sampling (Marnewick *et al.*, 2014; Nardi, 2018) was chosen.
		Selection of survey method (Gray, 2014; Nardi, 2018).	The questionnaire was determined to be the most suitable method to validate the quantitative descriptions found in the literature.
		Selection of survey instrument (Czaja and Blair, 2011; Marnewick *et al.*, 2014; Nardi, 2018).	Resource (time and money) availability was considered in the choice of the survey instrument. The chosen survey instrument was the web-based SurveyMonkey app.
		Draft the questionnaire (Czaja and Blair, 2011; Nardi, 2018).	A research questionnaire design (Table 5) was used to draft the questions for the questionnaire whilst adhering to quality and efficiency guidelines.
2.	**Pre-testing**	Pre-test the questionnaire (Czaja and Blair, 2011; Gray, 2014; Marnewick *et al.*, 2014).	The final draft of the questionnaire was used to conduct a pre-test - a pilot test was conducted on a small group of ASD academics and practitioners.
		Revise the questionnaire (Czaja and Blair, 2011; Marnewick *et al.*, 2014).	Based on feedback from the ASD academics and practitioners, the questionnaire was revised.
3.	**Survey implementation**	Conduct the survey (Marnewick *et al.*, 2014).	The questionnaire was deployed using the instrument SurveyMonkey.

No.	Stage of survey	Best practice process	Execution of process
	and data collection	Collect the data (Czaja and Blair, 2011).	Data was collected in an electronic format from the instrument's database.
		Validate the data (Gray, 2014).	Data were checked for accuracy and quality before using it.
4.	**Data analysis and reporting**	Data analysis (Nardi, 2018).	Data analysis involved a descriptive analysis and interpretation of the collected data.
		Final reporting (Czaja and Blair, 2011; Marnewick *et al.*, 2014).	Conclusions were drawn from the interpreted data and the rich description of communication patterns and their enablement of performance was presented.

3.3. Research questionnaire design

A structured questionnaire was chosen to obtain the data regarding the communication patterns and team performance measures in ASD teams. The overall design of the questionnaire was drafted to gain an understanding related to the two research questions discussed in Chapter 1 based on the insights from the literature in Chapter 2. A summary of the research questionnaire design is presented in Table 5.

Table 5: Research questionnaire design

Question	Description	Understanding	Reference
Research question 1	What are the known communication patterns within ASD teams?	The question seeks to identify patterns from the literature related to the communication process within ASD teams.	Linked to Chapter 2, Table 3.
Research question 2	How do the various identified communication patterns impact team performance?	The question seeks to determine if the communication patterns have an impact on team performance and what the measures of team performance are.	Linked to Chapter 2, Tables 2 and 3.

Besides using the high-level research questionnaire design, several other quality and efficiency factors were considered whilst developing the questionnaire:

- Closed-ended multiple-choice questions were used to elicit the required information. The list of provided responses included in the questionnaire was guided by the insights from the literature to enable validation of the insights.
- Fixed responses may limit a researcher's ability to adjust for cultural differences and to clarify misunderstandings and ambiguities (Nardi, 2018). This was mitigated by (1) targeting only ASD academics and practitioners who possess the knowledge and experience required to answer the questionnaire, (2) allowing a "not applicable" option for questions which were deemed to require specialised knowledge, (3) using easily understandable language, and (4) providing explanations, where applicable, for aspects being discussed.
- The wordiness, relevance, and redundancy of questions and responses were checked. Questions were designed to be as succinct as possible to lessen respondent fatigue (Lavrakas, 2013a).
- To accommodate the intensity of feeling towards the aspects being questioned, the Likert intensity-scales were used. This allowed for the capturing of the participant's agreement or disagreement with the aspect as well as how intensely they agree or disagree (Nardi, 2018).
- Loaded and leading questions were avoided to limit influencing the participant and to increase the reliability of the results.
- Mutual exclusivity of questions: participants were prompted to pick only one answer which most closely represented their opinion/attitude/behaviour. Targeting ASD academics and practitioners, filtering of questions, and including a "not applicable" option where applicable ensure that results are reliable and that the participant is not being forced to answer questions on aspects they are not familiar with.

The questionnaire went through an iterative process of being checked and revising questions by the researcher to produce a final comprehensive questionnaire. The questionnaire was then configured using SurveyMonkey and tested by the researcher. Further modifications were made to the questionnaire. Questionnaire duration testing was performed simultaneously before proceeding to pilot testing. A pilot test was conducted on a small group of ASD academics and practitioners from which comments for improvement were accommodated in the final questionnaire. The final questionnaire is included in **Appendix B: Questionnaire**.

3.4. Data collection

The target population was academics and practitioners currently employed in ASD teams in South Africa. The target population is very specific and considered challenging to identify. This would render the cost of surveying the general population to access the target population expensive (Baltar and Brunet, 2012). Hence, the non-probability snowball sampling technique was chosen to access the target population. Snowball sampling is a useful methodology in exploratory, qualitative, and descriptive research especially for small target populations or populations which require a high degree of trust for initial contact (Baltar and Brunet, 2012). Furthermore, Benfield and Szlemko (2006) explain that virtual snowball sampling facilitates access to hard to reach populations but more importantly, it can also increase the sample size and have associated cost and time benefits.

The snowball sampling technique involves identifying one or more members of the target population and asking them to identify other members of the same population that the survey can be forwarded to. These additional members are then asked to identify additional members of the population. This process continues until a suitable sample size is obtained or until no more members are elicited (Lavrakas, 2013b). For this research, two different approaches were followed to find participants within the researchers' networks and to initiate the referral chain of the snowball sampling:

- The researchers' established industry networks were utilised to initiate the snowball chains which targeted ASD academics and practitioners.
- The professional social media networking platform, LinkedIn, was utilised to initiate the snowball chains which targeted ASD academics and practitioners.

Known ASD academics and practitioners were identified and contacted directly to participate in the questionnaire. The questionnaire was forwarded to the ASD academics and practitioners who, once complete with the questionnaire, were requested to forward the questionnaire to other ASD academics or practitioners they knew. This process of forwarding the questionnaire to ASD academics and practitioners continued until a suitable sample size was acquired. Only initial involvement was required from the researcher for the targeted circulation of the questionnaire, after which subsequent referral of participants occurred exclusively via the network of similar-trained academics and practitioners.

The SurveyMonkey platform allowed for the instantaneous collection of data – as soon as participants clicked submit, the results of the questionnaire were available online via the database. Once the survey was deemed complete, the results were then exported in a suitable format (i.e. Microsoft Excel worksheet) to commence processing of the data.

3.5. Data analysis and presentation

Quantitative data analysis involves using statistics; therefore, the process of data analysis must take this into account. Figure 4 presents the main steps in quantitative data analysis as described by Rose et al. (2014).

Figure 4: Quantitative analysis process (Rose et al., 2014)

The first step in the analysis process is to organise the collected data into a format that can be analysed using a data analysis software program. SurveyMonkey allowed for the systematic collection of data as responses were submitted. The data was exported in a format that could be opened in the Microsoft Excel program (used for data analysis).

The second step in the analysis process involves preparing the data for analysis. It involves checking the data for errors, dealing with missing data, and transforming the data to enable data analysis (Rose et al., 2014). Checking the data for errors involves ensuring responses are within valid ranges for the variables, checking that rules have been adhered to when answering questions, checking for logical inconsistencies in questions, and confirming that the participants fall within the target population (Rose et al., 2014). The mentioned errors were not a problem for the survey used, however, a few respondents' results were incomplete and could not be used for the analysis.

The third step in the analysis process involves exploring the data using statistics and graphical display techniques to get a feel for the data set and what it implies about the target population (Rose et al., 2014). Choosing the analysis technique depends on the research questions, the level

of measurement used, and the number of variables being analysed simultaneously (Rose et al., 2014). This step involved exploring each variable individually and then exploring two or more variables simultaneously. Once the data was explored, the appropriate analysis techniques were applied to the data and the results were interpreted. The final step in the analysis process involved presenting the results of the analysis. A combination of tables and figures was used to present the results which were then discussed in more detail.

3.6. Ethical considerations

Several aspects of ensuring ethics in the research study were considered during the research design process. Since the questionnaire method of survey involves human interaction, the inadvertent harm that could be caused to participants had to be considered. Whilst planning the questionnaire, which aims to validate insights from the review of the literature, various ethical principles were considered to ensure (1) any negative impacts to the participants are minimised and mitigated as far as possible and (2) that the reputation of the University of Johannesburg, the supervisors, and the researcher are upheld and protected. The principles that were considered and the proposed actions for each principle are offered in Table 6.

Table 6: Summary of ethical considerations

No.	Key principle	Issues considered	Actions that were taken
1.	Avoidance of harm or loss of dignity (Rose et al., 2014).	Protection from physical, psychological (anxiety, embarrassment, or stress) harm and protection of personal dignity.	• The research was not considered to be controversial or sensitive. The harm associated with participating was determined to be minimal. • Pre-testing was conducted which enabled feedback on the appropriateness of the questions. • Participants' anonymity guaranteed minimal invasion of privacy regarding opinions.

No.	Key principle	Issues considered	Actions that were taken
2.	Transparency and honesty (Rose et al., 2014).	Informed consent: permission granted in full knowledge of consequences.	• Participants were made fully aware of the details surrounding the questionnaire through the inclusion of a cover letter.
		Benefit: advantage gained by the participants.	• Participants will not benefit directly from the research study, but the knowledge generation will benefit ASD academics and practitioners.
3.	Right to privacy (Rose et al., 2014).	Anonymity: the identity of the participant is not known to the researcher.	• The questionnaire was configured using SurveyMonkey in which the option to collect submissions anonymously was used.
		Confidentiality: participant's identity is known by the researcher but is protected from discovery by others.	• The collection of submissions was done anonymously and thus the identity of participants was not known. • The identification of participants was further prevented by the exclusion of the collection of personal biographical data.
4.	Researcher integrity (Rose et al., 2014).	Justice: is the fair selection of participants for research purposes.	• The questionnaire did not seek to intentionally exclude any disadvantaged groups; however, it was not possible for visually challenged individuals to participate. • Limiting participation to ASD academics and practitioners (target population) was unavoidable due to the nature of the research.
		Voluntary participation: participants fully consent to	• Participants could decide whether or not to participate.

No.	Key principle	Issues considered	Actions that were taken
		participate, without coercion.	• Participants had the option to withdraw from the questionnaire at any point before submission.

3.7. Quality considerations

Quality was embedded in all aspects of the research questionnaire design. During the design process of the questionnaire, the quality of the questionnaire was ensured by following recommendations for good questionnaire design etiquette as discussed in Section 3.3. Pilot testing and survey duration testing was done. The results and feedback from the testing were used to improve upon the questionnaire. Quality was ensured through reliability and validity considerations.

In quantitative research, reliability is a measure of consistency, repeatability, and stability (over time) of research (Mohajan, 2017; Gray, 2014) i.e. that consistent results were achieved in identical situations under different circumstances. Reliability is considered necessary, but not a sufficient condition for the validity of the research (Mohajan, 2017). The attributes of reliability include stability (over time), equivalence (administering two versions of a test instrument to the same people on the same day), and inter-judge reliability (internal consistency). For this research study, the threats to reliability were identified and mitigated. These threats include (1) lack of clear instructions, (2) not providing all alternatives, (3) nonsensical ordering of the questions, (4) ambiguity in questions leading to misunderstanding, and (5) including long and difficult to read questions (Mohajan, 2017). There are several ways of determining reliability such as test-retest, parallel form, inter-item, split-half, and inter-rater reliability (Nardi, 2018). For this research., split-half reliability, through the utilisation of Cronbach's alpha reliability coefficient, was used to indicate the internal consistency of the questionnaire items.

The validity of a research instrument assesses the extent to which the instrument measures what it is supposed to measure (Mohajan, 2017). The face validity is the extent to which a test appears to measure what it claims it measures (Mohajan, 2017). The face validity of the questionnaire was assessed to determine if the insights from the literature were being addressed adequately. Construct validity determines, more precisely than face validity, whether the questionnaire

measures the variable it was intended to measure (Gray, 2014). Construct validity was ensured by using a table to list in separate columns the research questions, the variables being measured, and how the required information was to be collected.

3.8. Conclusion

The research methodology provides a blueprint for the execution of the answering of the research aim through the research questions. The research methodology aims to validate the insights from the literature via ASD academics and practitioners. The chapter provides the chosen research method and instrument, how the data was collected, analysed, and chosen to be presented, and ethical and quality considerations.

The chosen research method, survey, is appropriate for the measurement of the descriptive communication patterns and team performance measures due to its ability to measure behaviours and phenomena of populations. Furthermore, a quantitative survey was chosen due to its appropriateness for identifying patterns and making generalisations. The snowball sampling technique enabled the collection of data from the specific and hard-to-reach ASD population resulting in suitable validation of the insights from the literature.

4. Chapter 4: Results and discussion

4.1. Introduction

Communication has time and time again been ascertained as a key variable in the performance of teams in achieving project success (Discenza and Forman, 2007; MacKellar, 2012; Kortum and Klunder, 2017). The lack of accord regarding the communication aspects that enhance team performance prompted this research. Therefore, identifying communication patterns and team performance measures within ASD teams is the aim of this research. To investigate this problem, the known communication patterns and team performance measures in ASD teams were identified via a review of the literature.

The questionnaire was selected as the most appropriate means of collecting data from ASD academics and practitioners to validate the insights from the literature. Chapter 4 will illustrate how the data collected from the questionnaire was examined to confirm, partially confirm, or reject the insights from the literature. The results from the questionnaire are presented in the most suitable tabulated and/or graphical manner and meaningful understanding and deductions are extracted from the information presented.

4.2. Data exploration

The data analysis process initially involved a descriptive analysis of the data collected. This process included univariate and bivariate analysis resulting in tabulated and/or graphical representations of the data (Nardi, 2018). The next layer of interpretation of the data included using applicable measures of central tendency (i.e. average and weighted average) where necessary for further understanding of certain patterns.

Gliem and Gliem (2003) provide that Cronbach's alpha is a test reliability technique that measures the strength of internal consistency (i.e. how closely related a set of items are as a group). Cronbach's alpha reliability coefficient normally ranges between 0 and 1 with values above 0.7 being considered as acceptable. When using Likert intensity-scales, it is encouraged to report Cronbach's alpha coefficient for internal consistency reliability (Gliem and Gliem, 2003). Using SPSS, Cronbach's alpha reliability coefficient was determined for the 82 items in

the questionnaire. A value of 0.722 was achieved which is considered to be acceptable reliability.

4.3. Respondents profile

The questionnaire was circulated to the researcher's established industry networks of ASD academics and practitioners within South Africa. A total of 21 ASD academics and practitioners completed the questionnaire successfully. The completion rate calculated for the questionnaire is 78%, which is thought to be very good. From Figure 5, it can be seen that the sample's demographic is relatively widespread.

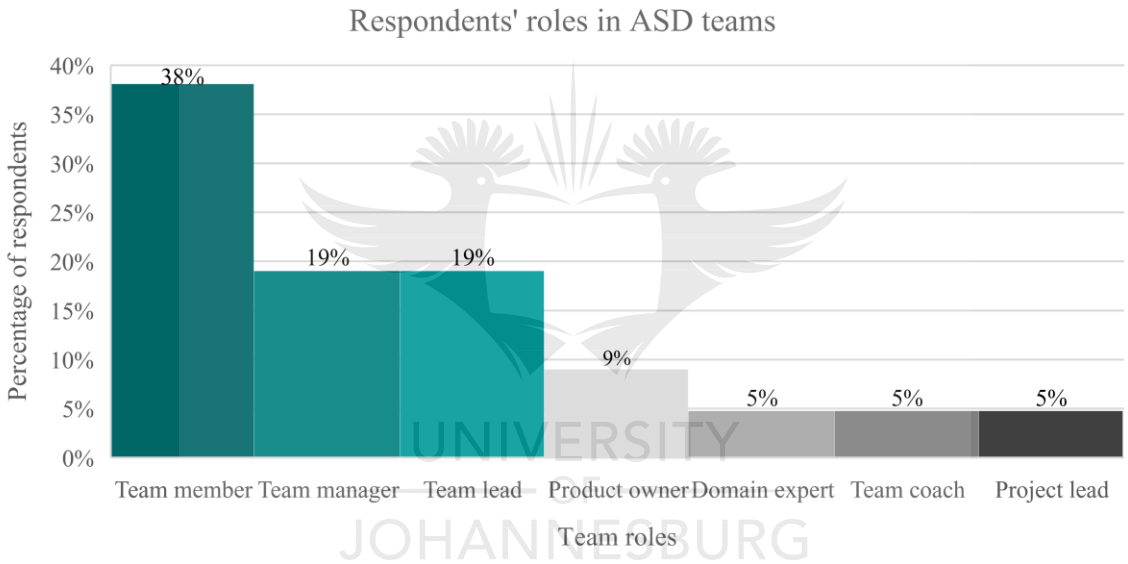

Figure 5: Respondents' roles in ASD teams

Responses from many of the different types of roles in ASD teams were collected, however, a lack of responses from the stakeholder and customer type roles is noted. Most respondents are from the team member (38%) type of role. Interestingly, a significant number of responses were also collected from team management types of roles i.e. from the team manager (19%), team lead (19%), and project lead (5%). The feedback from the combination of team member and team management types roles is thought to provide well-rounded data.

Figure 6 shows that most respondents (76%) indicate that they have at least 3 or more years of experience on ASD projects. Furthermore, nearly half (i.e. 47%) of the respondents have at

least 6 or more years of experience on ASD projects. These results highlight the maturity of the respondents within ASD teams.

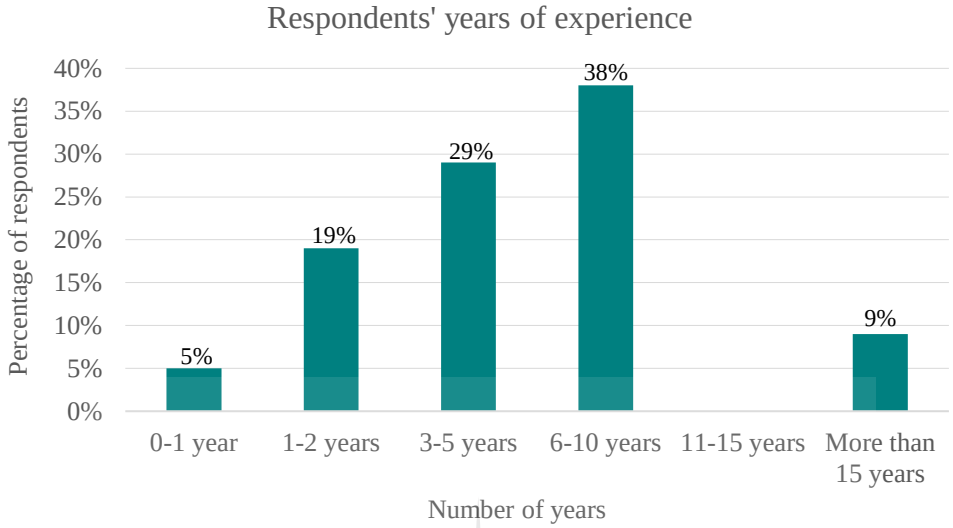

Figure 6: Respondents' years of experience on ASD projects

The breakdown of respondents summarised in Table 7, shows a good distribution of respondents' years of experience and respondents' roles in ASD teams. As such, one would expect a variety of experiences due to the maturity of the respondents resulting in insightful data.

Table 7: Respondents breakdown

Role in ASD team	**Number of years of experience**						**Total**
	0-1	**1-2**	**3-5**	**6-10**	**11-15**	**> 15**	
Team member	1	3	2	2	0	0	8
Team manager	0	1	1	1	0	1	4
Team lead	0	0	1	3	0	0	4
Product owner	0	0	1	1	0	0	2
Domain expert	0	0	0	0	0	1	1
Team coach	0	0	1	0	0	0	1
Project lead	0	0	0	1	0	0	1
Total	1	4	6	8	0	2	**21**

4.4. Communication patterns in ASD teams

A review of the literature on communication within ASD teams revealed certain generalisable communication patterns. These insights formed the basis of the questionnaire which was used to determine the validity of these patterns.

4.4.1. Leadership in ASD teams

The literature found a shift from person-centred leadership to team-centred leadership (Romijn, 2016) with servant-leadership being the preferred leadership style in ASD teams (Marnewick and Marnewick, 2020). It would seem that this facilitative style of leadership allows the team to take responsibility for their work which results in increased information sharing within the team.

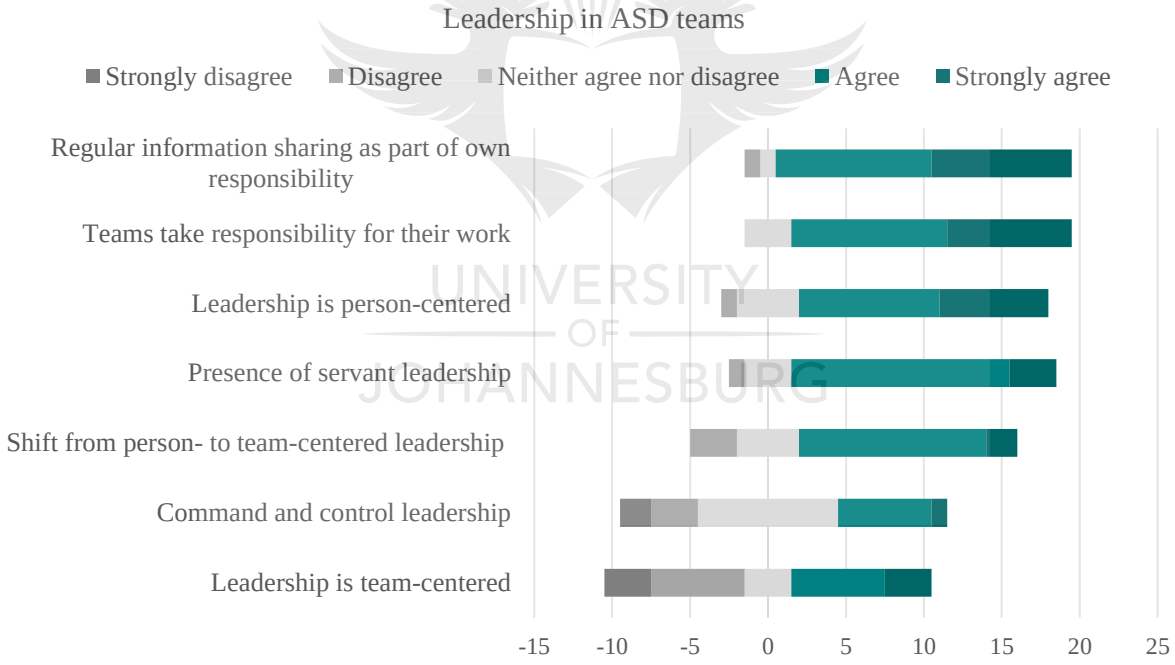

Figure 7: Leadership in ASD teams

The strong agreement regarding regular information sharing within teams and team members being allowed to take responsibility for their work supports the notion that information sharing increases within teams when initiated by leaders that delegate responsibility unto their teams. There seems to be reasonably strong agreement with the presence of servant leadership within

ASD teams and almost equal support for person-centred leadership. It seems that leadership lacks team centricity however a shift from person-centred to team-centred leadership is evident. This is validated by the combination of the presence of command and control type leadership as well as servant leadership within these teams.

Two measures of central tendency were used for data analysis. The average expresses the central or typical value in a data set and is calculated by adding all the values in a data set and then dividing by the number of values in that data set (Maloney, 2018). The average is useful for getting a sense of where the values in a data set are typically lying. The weighted average is a calculation that takes into account the varying degrees of importance of the values in a data set (Ganti, 2020). In this research study, the varying degrees of importance arise from the use of the Likert intensity-scales. The weighted average, as indicated by the formula* below, is calculated by multiplying each data point value by the assigned weight which is then summed and divided by the sum of all the weights (Ganti, 2020). The use of the weighted average allows for the ranking of the data values (i.e. the statements used in the questionnaire to confirm the patterns).

$$\text{*Weighted average} = \frac{\text{Sum of all the data point values multiplied by their respective weights}}{\text{Sum of all the weights}}$$

Table 8: Agreement with leadership patterns based on average

Leadership patterns	Average
Leadership is person-centred	4,05
Leadership is team-centred	3,00
Shift from person- to team-centred leadership	3,62
Presence of servant leadership	3,90
Command and control leadership	3,05
Teams take responsibility for their work	4,24
Regular information sharing as part of own responsibility	4,29

Exploring the average of the leadership patterns, the data represented in Table 8 reveals that there is sound agreement that teams that are allowed to take responsibility for their work (average of 4.24). Also, an increase in information sharing that forms part of taking

responsibility for one's work (average of 4.29) confirms the initial understanding of these patterns. There is also a good deal of agreement that leadership is person-centred and thereafter that the servant leadership style is present in ASD teams. There is a lack of agreement regarding the presence of team-centred leadership and the command and control type of leadership which once again may allude to the transition of leadership style.

4.4.2. Medium of communication in ASD teams

The medium of communication was identified as a driver for success in ASD teams. The various studies supporting MRT and MST were discussed. In summary, face-to-face communication which is a richer media, according to MRT, and a highly synchronous medium, according to MST, was found to be superior to other asynchronous media used for communication (Andres, 2002; Green *et al.*, 2010).

Figure 8 shows that face-to-face communication is not the preferred medium of communication over the entirety of the project lifecycle. Instead, asynchronous communication in the form of instant messaging and email ranked higher than all other media for the overall project lifecycle. As posited by MST, it is likely that ASD academics and practitioners utilise media according to information requirements (Han et al., 2011). Therefore, as suggested in the literature, media appropriateness posited by MST is supported. This is reinforced by understanding the results presented in Figure 9 and Table 9 which show that different communication media are preferred during different project phases. Face-to-face communication is undoubtedly preferred during the inception phase of the projects whilst asynchronous communication such as instant messaging and email are preferred during the later production and retirement phases, respectively. Audio conferencing is used during the intermediate phases of the projects i.e. iteration and release phases. These trends are in line with the finding by Green *et al.* (2010) who determined that richer communication media are used during the earlier phases of the project. Thus, MST and MRT are both supported.

The questionnaire was designed and distributed to participants during the period of the COVID-19 pandemic. The results were collected from respondents during a period where South Africa was under one of the intermediate lockdown levels. During this period, many people were still predominantly working from home as far as possible. The working from home dynamic, as opposed to the usual working habits, meant that data collection reported on habits largely

occurring during this irregular period. It is apparent that the COVID-19 pandemic and working habits of ASD teams are slightly different from the normal operation of ASD teams. This is specifically seen in (1) the lack of preference for the use of face-to-face communication in all other phases of the project lifecycle, except the inception phase and (2) the preference to use asynchronous communication and audio conferencing, which is different from the norm.

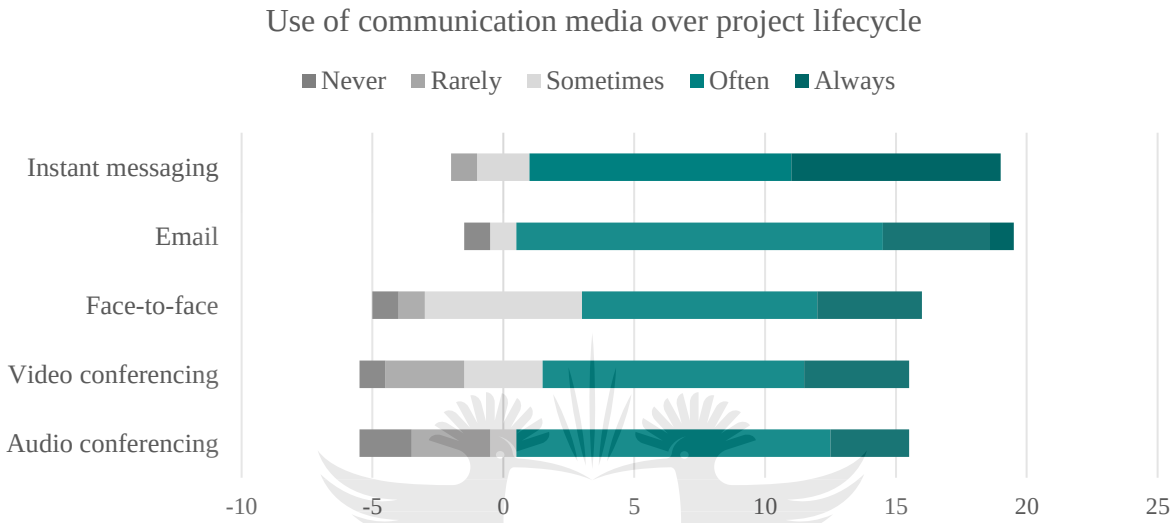

Figure 8: The use of communication media over the project lifecycle

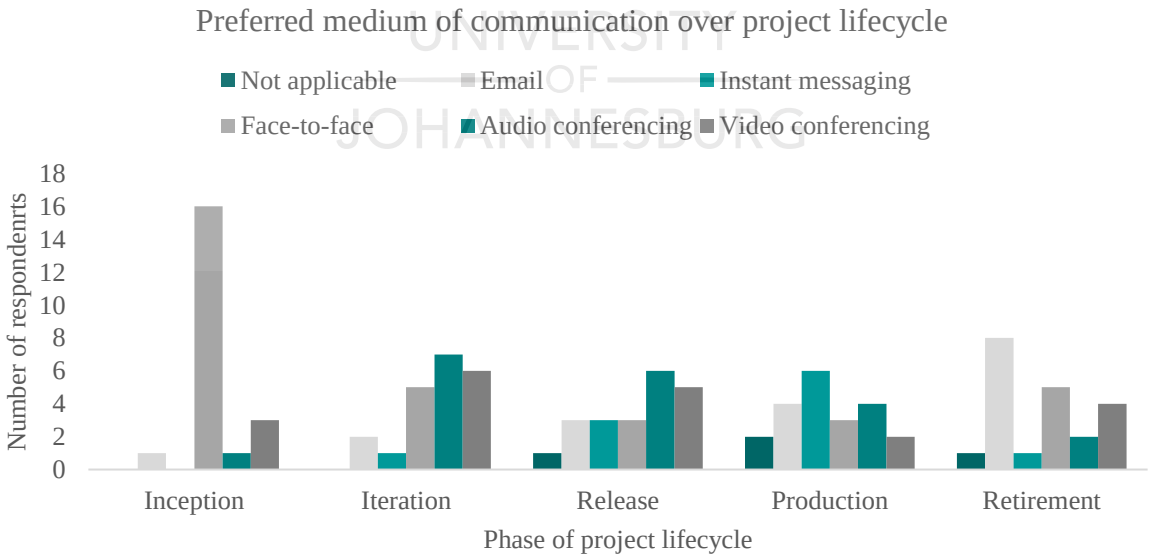

Figure 9: The preferred medium of communication over project lifecycle

Table 9: The preferred medium of communication over project lifecycle

Phase of project	Preferred medium	Supporting responses
Inception	Face-to-face	16 out of 21
Iteration	Audio conferencing	7 out of 21
Release	Audio conferencing	6 out of 21
Production	Instant messaging	6 out of 21
Retirement	Email	8 out of 21

4.4.3. Use of communication media within ASD teams based on team distribution

ASD prescribes collocation to enable effective communication and for teamwork to be successful. From the literature, it was found that collocated teams prefer face-to-face communication whereas distributed teams prefer email communication. The level of agreement with the insights from the literature was determined. Table 10 presents a summary of the weighted averages calculated for the use of communication media based on location over the project lifecycle.

It is immediately clear from Table 10 that face-to-face communication is the preferred choice of communication for collocated teams. This affirms the insights from the literature. For distributed teams, the use of email is confirmed as the preferred choice of communication. However, instant messaging is tied with email communication as the preferred medium of communication. In essence, both email and instant messaging are considered synonymous as they are asynchronous means of communicating.

Table 10: Weighted average of communication media for collocated and distributed teams

Medium of communication	Weighted average	
	Collocated	Distributed
Email	5.07	5.67
Instant messaging	5.27	5.67
Face-to-face	5.93	2.87
Audio conferencing	3.33	4.93
Video conferencing	3.00	4.60

Yagüe et al. (2016) found that communication is improved through the use of communication media to create closeness, regardless of team distribution. The results from the questionnaire, presented in Figure 10, strongly endorses this. Supporting this is the lack of significant agreement on whether collocated teams communicate more efficiently than distributed teams. Both results support the notion that media appropriateness during a project's lifecycle is vital for communication (Green *et al.*, 2010; Fernando *et al.*, 2011).

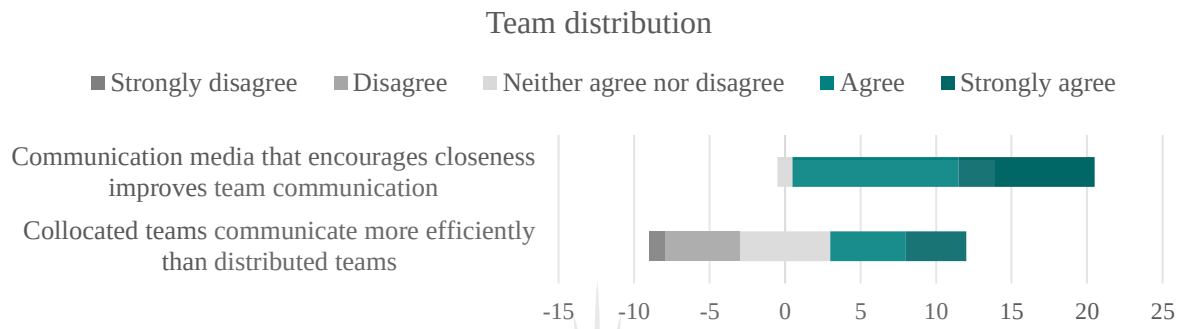

Figure 10: ASD team distribution

4.4.4. Characteristics of ASD teams

The team performance model is influenced by various inputs that facilitate the team communication process. These inputs impact team communication processes and are accompanied by enablers which add to the team dynamics. Team characteristics such as team diversity, team size, and project type may facilitate or inhibit the communication process (Marlow *et al.*, 2017).

Team diversity has been linked to a lack of common understanding. The lack of common understanding inhibits effective communication, especially regarding communication quality and communication frequency (Marlow *et al.*, 2017). Some key observations are extracted from Figure 11. There is consensus that difficulty in understanding information, reduced communication frequency, and reduced communication quality contribute to a lack of common understanding. However, contrary to the literature, team diversity is not negatively influenced by understanding information. Furthermore, team diversity does not seem to be influenced by communication frequency and communication quality.

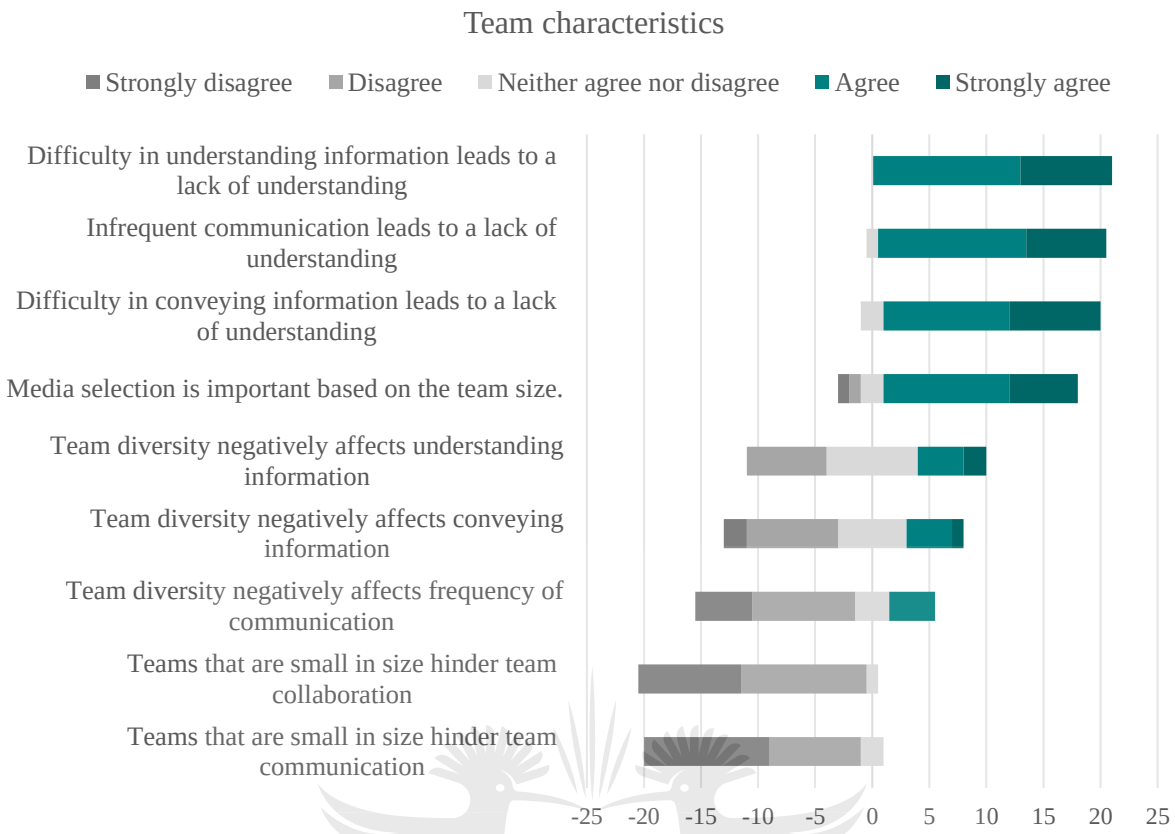

Figure 11: ASD team characteristics

Regarding common understanding, it can be deduced that team diversity is not significantly impacted by the team's communication processes (in terms of communication frequency and communication quality) but there is strong agreement that difficulty in understanding information, reduced communication frequency, and reduced communication quality do indeed affect the team's common understanding. Therefore, there seems to be no link between team diversity and a lack of common understanding but rather a link between effective team communication and a lack of common understanding. Regarding team size, the link between media selection and team size is evident. Team size does not seem to affect communication and collaboration within ASD teams as evidenced by the disagreement in Figure 11 and the disagreement echoed in the average respondents' replies in Table 11.

A more in-depth look at Table 11, which shows the ASD team characteristics confirms the results from the initial descriptive analysis of the data i.e. there is sound agreement that difficulty in understanding information, reduced communication frequency, and reduced communication quality contribute to a lack of common understanding as is evidenced by higher

averages in Table 11. The low averages for the impact of team diversity on information exchange and communication frequency illustrate that there is a lack of agreement that diverse teams affect communication within ASD teams. There is also general disagreement that teams that are small in size hinder communication and collaboration. Lastly, media selection for different team sizes has a relatively high average of 3.95 which confirms its importance. The disagreement regarding small teams hindering communication and collaboration allude to the observations regarding media selection appropriateness based on team size.

Table 11: Agreement with team characteristics patterns based on average

Team characteristics patterns	Average
Team diversity negatively affects conveying information	2,71
Team diversity negatively affects understanding information	3,05
Team diversity negatively affects frequency of communication	2,29
Difficulty in conveying information leads to a lack of understanding	4,29
Difficulty in understanding information leads to a lack of understanding	4,38
Infrequent communication leads to a lack of understanding	4,29
Teams that are small in size hinder team communication	1,57
Teams that are small in size hinder team collaboration	1,62
Media selection is important based on the team size.	3,95

4.4.5. Project type within ASD teams

There is a lack of information on how project types affect the team communication process. The type of project work currently being undertaken by the ASD academics and practitioners was first determined.

Figure 12 shows the diversity of the type of projects currently being undertaken by the ASD academics and practitioners. There is substantial project work being conducted on mission-critical projects. The general diversity of projects provides a holistic representation of project work in ASD teams.

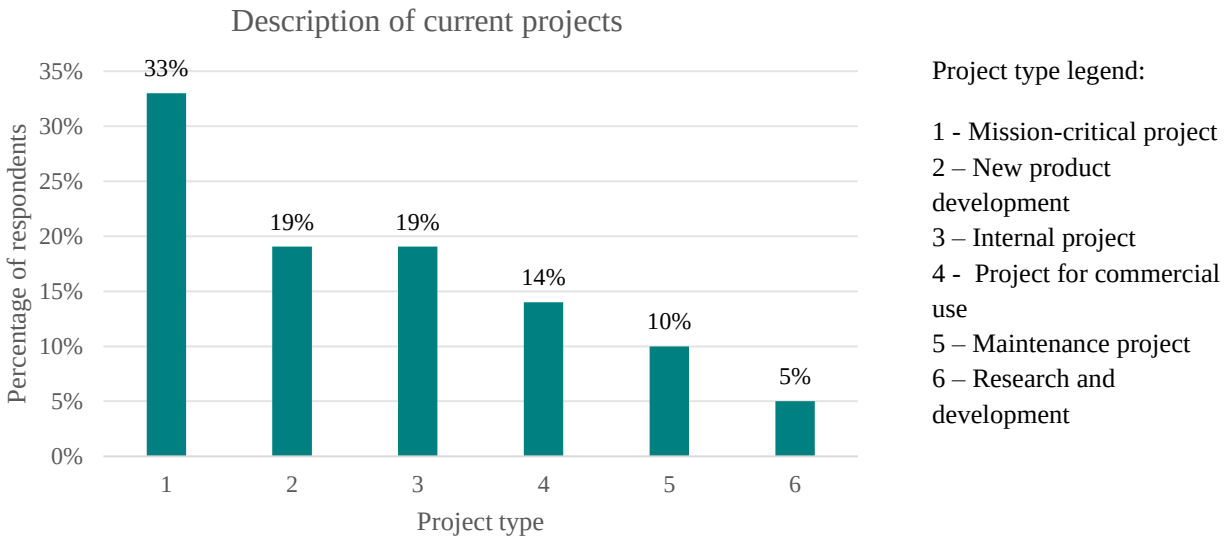

Figure 12: Description of current ASD projects

From the literature, communication frequency and face-to-face communication were identified as possible drivers for success in mission-critical projects (Hummel *et al.*, 2013). Also, using only oral communication (which includes both face-to-face and any form of virtual verbal communication) may be problematic later on in maintenance projects due to the lack of documentation (Hummel *et al.*, 2013).

Figure 13 summarises the feedback regarding all project types and shows reasonable agreement that face-to-face communication and communication frequency influences project success. This reasonable agreement is also seen by the averages in Table 12 for face-to-face communication and communication frequency. By isolating only mission-critical projects, the averages in Table 12, for face-to-face communication influencing project success (i.e. 3.86) and communication frequency influencing project success (i.e. 3.43) confirm that they are indeed potential drivers for project success. However, it is noted that the agreement is not strong but is reasonable.

Oral communication appears to be important in all phases of a project. Lastly, there is some agreement that the project type influences the communication process.

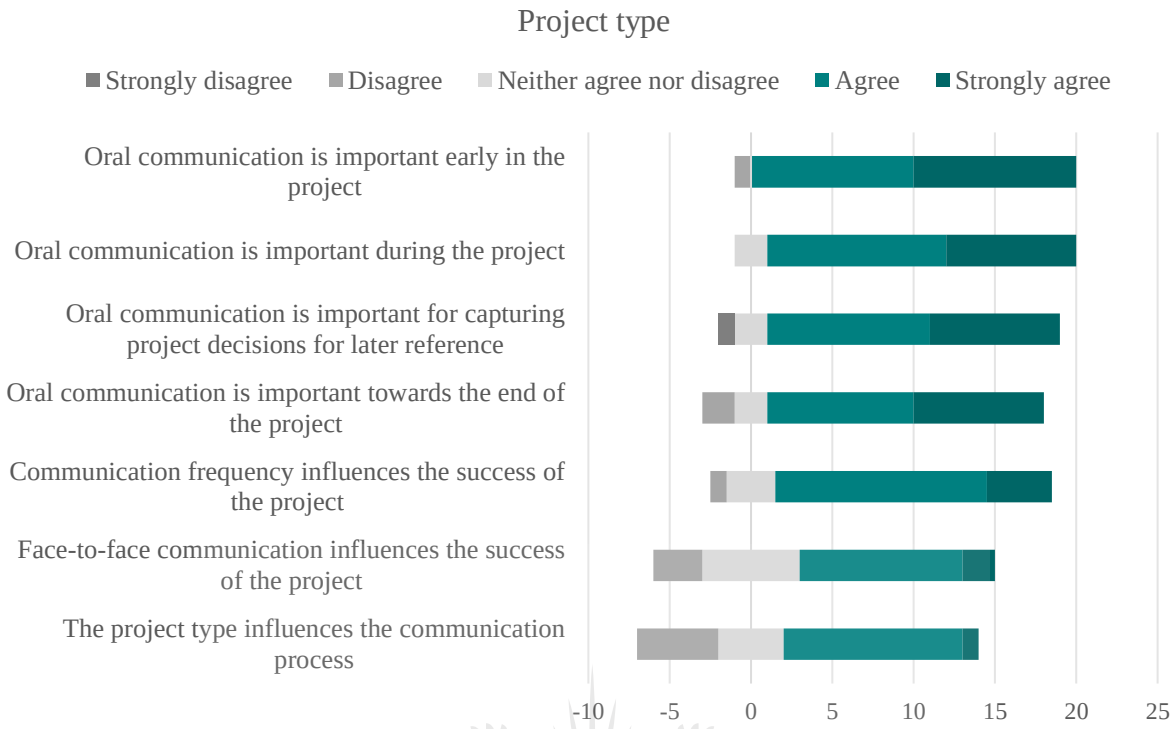

Figure 13: ASD project type

Table 12: Agreement with effect of communication on mission-critical projects based on averages

Influence on project success	Average
The frequency (how often) of communication influences the success of the project.	3,86
Face-to-face communication influences the success of the project.	3,43

4.4.6. ASD team cognition and trust

Team cognition and trust have been recognised as enablers in the team communication process (Espevik *et al.*, 2006; He *et al.*, 2007). The literature determined that the transfer of knowledge from an individual to the team leads to increased shared team understanding (Liang *et al.*, 1995; Moreland and Myaskovsky, 2000; Lewis, 2004). There is significant agreement, as can be seen in Figure 14, that the transfer of knowledge from an individual's knowledge to shared team knowledge leads to maturity of team cognition.

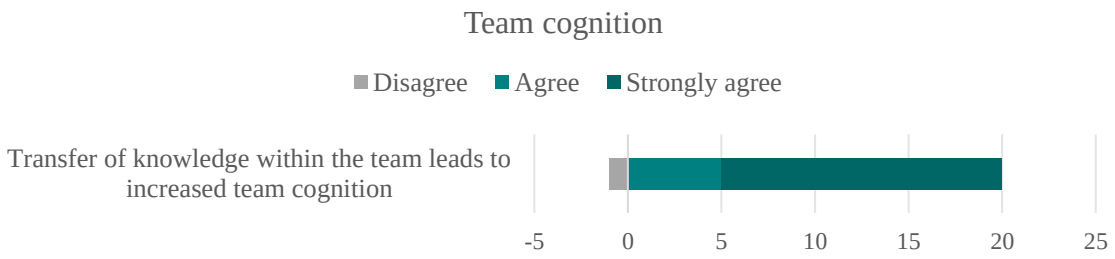

Figure 14: Team cognition in ASD teams

The role of communication in building trust in ASD teams is underlined in the literature. Increasing communication frequency, knowledge sharing, and feedback in ASD teams increase common awareness and cohesion in teams (McHugh *et al.*, 2012). The development of common awareness and cohesion in teams results in the maturity of trust (McHugh *et al.*, 2012). The data regarding team trust presented in Figure 15 very strongly confirms all the insights from the literature regarding trust.

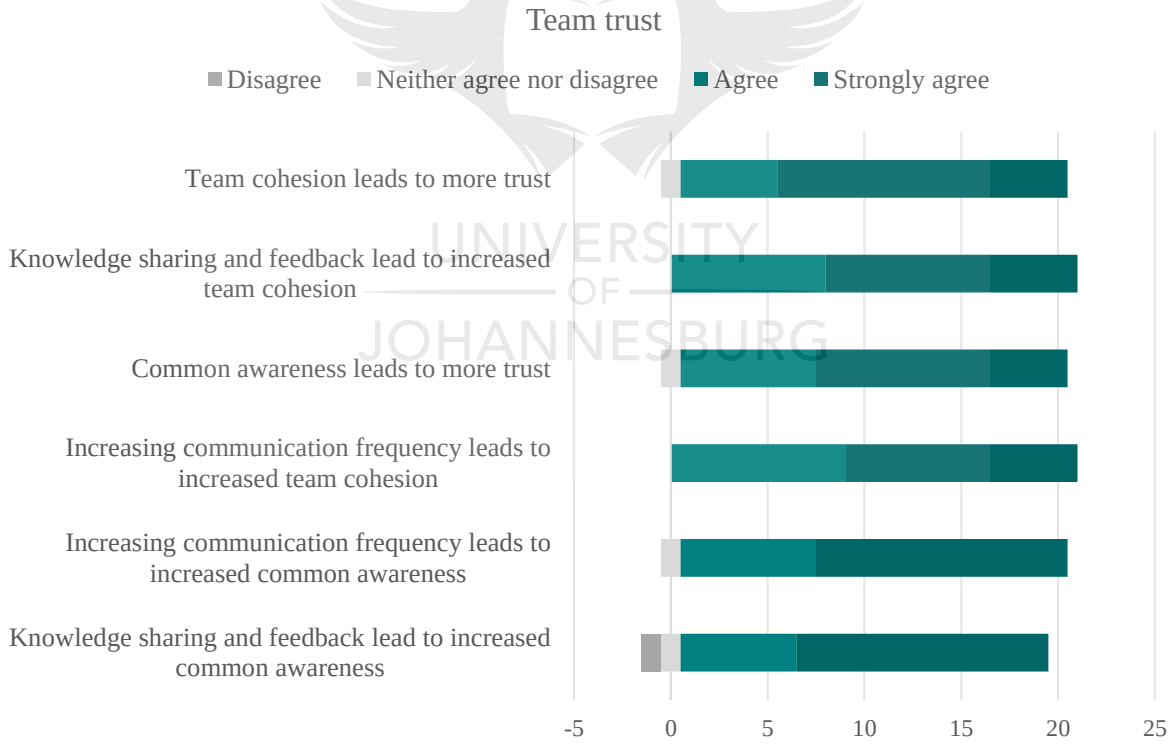

Figure 15: ASD team trust

4.4.7. Communication in ASD teams

Communication within an ASD team has been described in the literature in terms of communication content, communication quality, and communication frequency. In terms of communication content, there were no generalisable communication patterns discerned however, certain insights regarding communication content were included in the questionnaire. The literature found that emails are used mainly to coordinate routine tasks (Wasiak *et al.*, 2011). Figure 16 confirms that email is preferred over face-to-face communication to coordinate routine tasks, but the preference is not substantial. The literature also found that in terms of the reason for communicating, five types of collaborative behaviour were identified related to project communication content. These are planning, contributing, seeking input, reflection/monitoring, and social interaction (Serce *et al.*, 2009). ASD teams spend most of their time on the planning type collaborative behaviour which is evident in Figure 17. Social interaction was the least used reason for communicating.

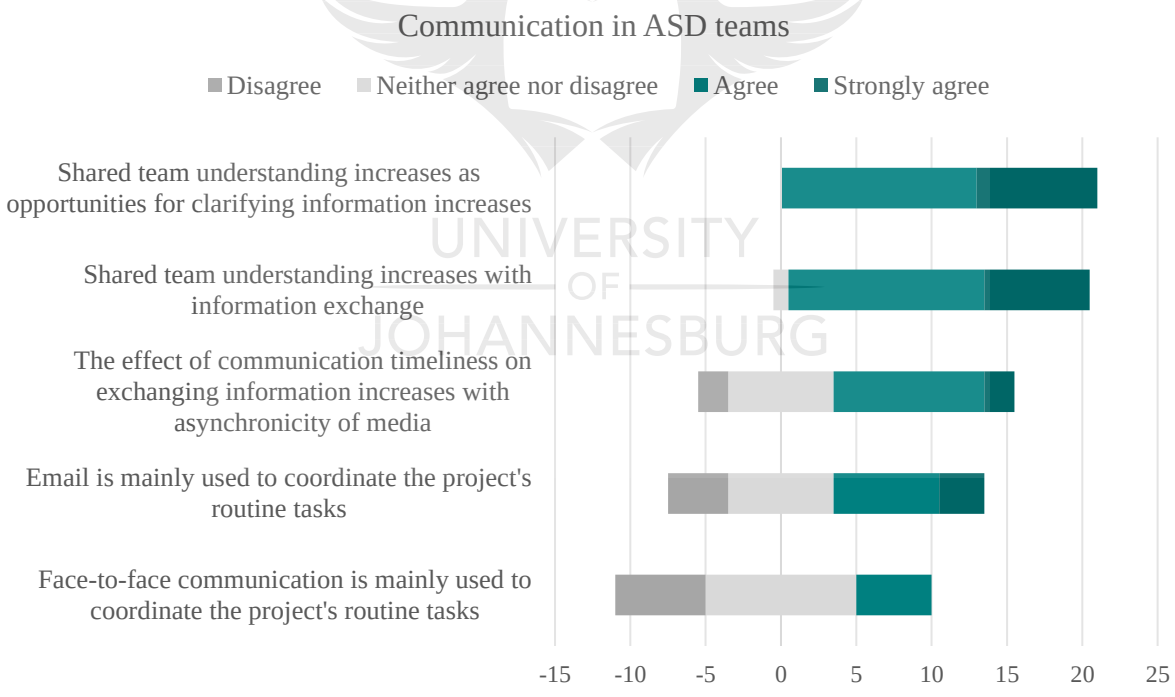

Figure 16: Communication in ASD teams

Communication quality is described using the measurements of communication timeliness and closed-loop communication (Dingsøyr and Lindsjørn, 2013; Marlow *et al.*, 2017). The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of CMC increases (Marlow *et al.*, 2017). Closed-loop communication allows

more opportunities for information exchange and clarification which contributes to improved shared understanding (Marlow *et al.*, 2017).

Figure 17: Reasons for communicating over the project lifecycle

From Figure 16, it is apparent that there is reasonable agreement that communication timeliness affects information exchange more as asynchronicity increases. As is evidenced in Figure 16, there is strong agreement that as opportunities for exchanging information and clarifying information increases, so does shared team understanding. Overall, it is clear that communication quality impacts shared team understanding.

Communication frequency facilitates information sharing which may increase team cognition (Patrashkova-Volzdoska *et al.*, 2003; Espinosa *et al.*, 2015). There is significant agreement that shared team understanding increases with information exchange, as shown in Figure 16. Furthermore, there is significant agreement that team cognition increases as opportunities (i.e. frequency) for clarifying information increases. Combining these two deductions, it is deduced that communication frequency facilitates information sharing which increases team cognition.

4.5. Team performance in ASD teams

From the literature, it was deduced that there is no specific standard measurement of team performance. Research on leadership, communication, and characteristics within ASD teams

reveal various insights regarding performance within these areas. Medium of communication, communication technique, measures of communication, and team cognition were identified as possible drivers for team success. Furthermore, team performance was found to be described using many different performance measures.

Figure 18 illustrates the results regarding drivers for success in ASD teams. There is strong agreement with all the statements and a summary of the results confirmed via the data analysis are as follows:

- The medium of communication is a driver for team success.
- Face-to-face communication increases team performance.
- The dialogue technique enhances team performance, regardless of the medium of communication.
- Communication frequency which facilitates transfer of knowledge increases shared team understanding (i.e. team cognition) and team performance.
- The exchange of information within ASD teams needs to be moderated as the extremes of information sharing can hinder team performance.

The literature is inundated with various measures of team performance. The relative importance of the measures is unknown. The data analysis sought to determine a relative importance of the various measures and identify distinct measures of performance. Figure 19 displays the measures of team performance after being sorted according to weighted average. Unsurprisingly, communication was ranked the most important measure followed closely by team effort and employee job satisfaction. The literature is inundated with the necessity for effective communication. However, a trend that one is immediately drawn to is that the measures identified seem to all be important in determining team performance. There seems to be no adamant disagreement with any of the measures which could imply that the team dynamic is governed by a multiplicity of various team performance measures.

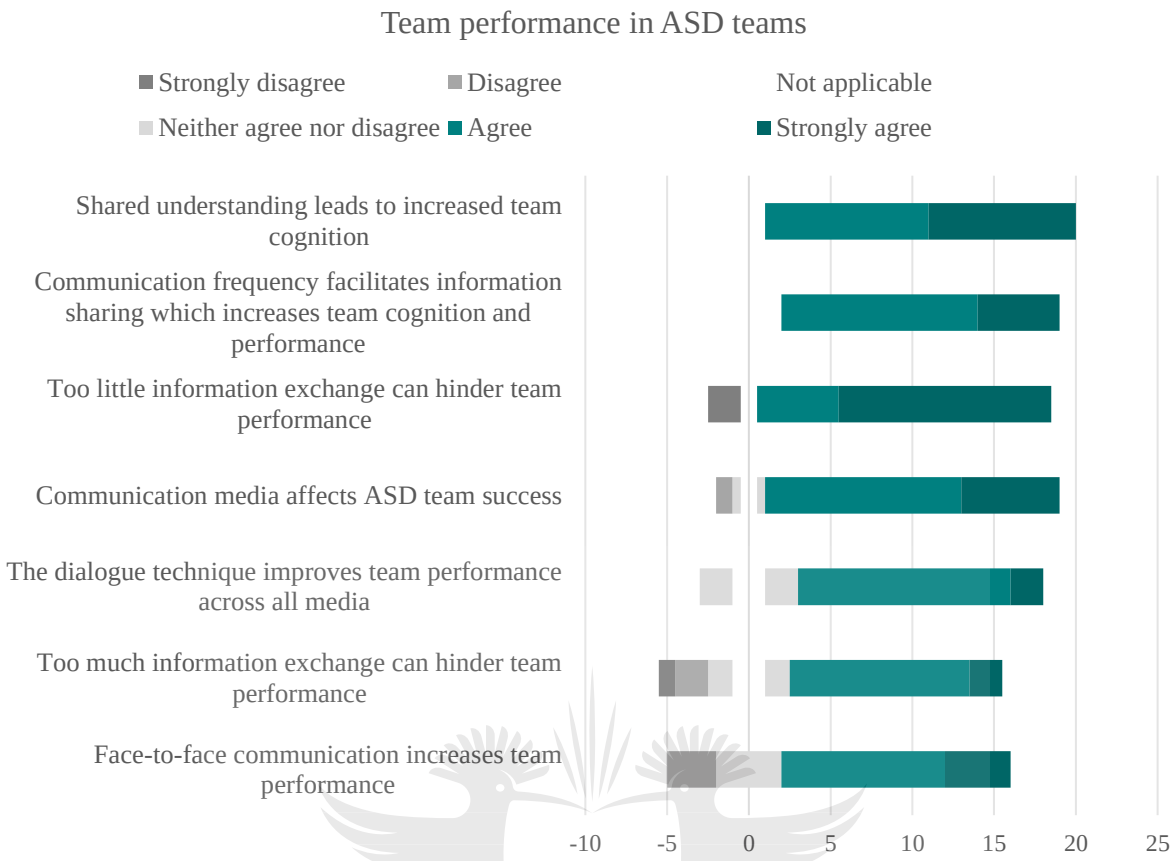

Figure 18: Team performance in ASD teams

The review of the literature regarding the most accepted measures of team performance found that communication and team cohesion are the most acceptable followed by team productivity, team member satisfaction, process satisfaction, and decision-related criteria. Of the mentioned measures, communication ranks first, in Table 13, when sorted according to the weighted average. The only other measure that is common to the literature and the data analysis' results is team productivity.

Table 13: Top six team performance measures

Ranking	Performance measure	Weighted average
1	Communication	5,38
2	Team effort	5,29
3	Employee job satisfaction	5,14
4	Mutual support within the team	5,14
5	Team productivity	5,05
6	Coordination within the team	5,00

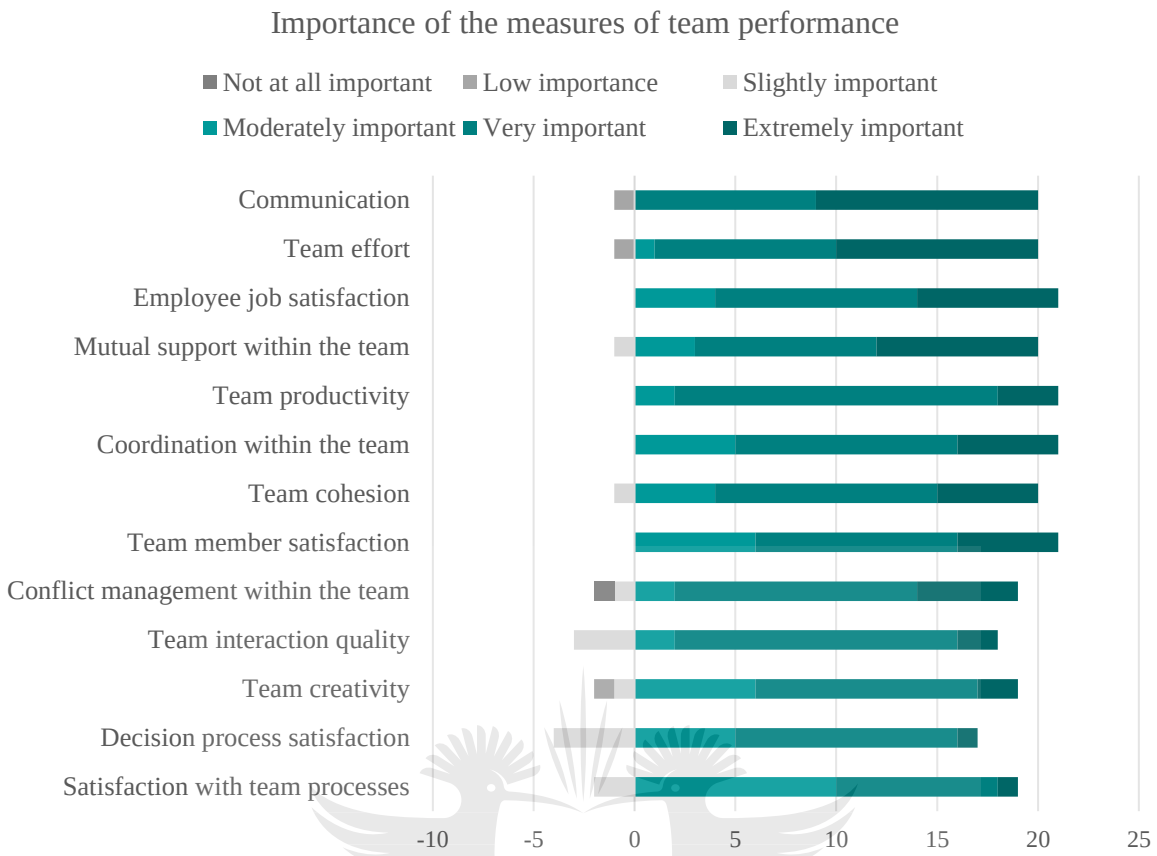

Figure 19: Importance of the measures of team performance in ASD teams

4.6. Interpretation of the results of the questionnaire

The understanding of the results of the data analysis has been discussed in detail in the preceding sections of this chapter. The insights concerning the various communication patterns and ASD team performance from the literature, summarised in Table 3, have once more been presented in Table 14, along with the deductions regarding each insight based on the results presented in Chapter 4.

Table 14: Summary of deductions made from the questionnaire results regarding insights from the literature

Category	**Main findings**	**Deductions**
Leadership	There is a shift from person-centred leadership to team-centred leadership.	Reasonable agreement with the presence of a shift in leadership – pattern confirmed.

Category		Main findings	Deductions
		Servant leadership is the preferred leadership style for ASD teams.	Reasonable agreement with the presence of servant leadership in ASD teams – pattern confirmed.
		There seems to be an increase in information sharing within the team initiated by leaders that allow teams to take responsibility for their work.	Sound agreement with an increase in information sharing due to increased responsibility – pattern confirmed.
Medium of communication		Medium of communication is a possible driver for team success.	Medium of communication is a driver for team success – pattern confirmed.
		Face-to-face communication is the preferred medium for communication and results in increased team performance.	Face-to-face communication is preferred only during the inception phase of the project lifecycle – pattern rejected. Face-to-face communication increases team performance – pattern confirmed.
		There is evidence supporting the need to choose appropriate media for communication during the ASD project lifecycle.	Support for media appropriateness is evident – pattern confirmed.
		The dialogue technique can be used to improve team performance for teams using both synchronous and asynchronous communication media.	The dialogue technique enhances team performance regardless of the medium of communication – pattern confirmed.
Team processes	**Team distribution**	Collocated teams communicate more efficiently.	Lack of substantial agreement that collocated teams communicate more efficiently than distributed teams – pattern rejected.

Category		Main findings	Deductions
Team processes	Team distribution continued	Collocated teams prefer face-to-face communication whereas distributed teams prefer email communication.	Strong agreement with face-to-face and email being preferred by collocated and distributed teams respectively – pattern confirmed.
		Irrespective of team distribution, communication media that encourages closeness improves team communication.	Strong agreement with improvement of team communication with any communication media that encourages closeness – pattern confirmed.
	Team characteristics	Diverse teams experience difficulties communicating (especially regarding communication quality and frequency) which results in a lack of common understanding.	Lack of support for the adverse impact of team diversity on understanding information, communication quality, and communication frequency however, there is strong agreement that difficulty in understanding information, reduced communication quality, and reduced communication frequency contribute to a lack of common understanding – pattern partially confirmed.
		Team size may hinder communication and collaboration in teams.	Reasonable disagreement that small teams hinder communication and collaboration – pattern rejected.
		Communication media appropriateness increases in importance with the size of the team.	Reasonable agreement that media appropriateness is important based on the team size – pattern confirmed.

Category		Main findings	Deductions
Team processes	Project type	In general, there is a lack of information on how project types affect the communication process.	Some agreement that project type influences the communication process – pattern confirmed.
		Communication frequency and face-to-face communication are possible drivers for success in mission-critical projects.	Some agreement that communication frequency and face-to-face communication are drivers for project success – pattern confirmed.
		Using only oral communication may be problematic later on in maintenance projects due to a lack of documentation regarding implemented system changes.	Reasonable agreement that oral communication is important at all phases of the project – pattern partially confirmed.
	Team cognition	Transfer of knowledge from an individual to the team (i.e. shared understanding) leads to increased team cognition which results in increased team performance.	Significant agreement that transfer of knowledge within ASD teams increases team cognition - partially confirmed.
	Trust	Increasing communication frequency, knowledge sharing, and feedback increase common awareness and team cohesion which results in the maturity of trust in ASD teams.	Significant agreement that increasing communication frequency, knowledge sharing, and feedback increases common awareness and team cohesion which increases trust within ASD teams – pattern confirmed.
Communication	Content	No generalisable patterns regarding communication content, however, the following was noted for confirmation: • Email is preferred over face-to-face communication to coordinate routine tasks.	Email is preferred over face-to-face communication to coordinate routine tasks – results noted.

Category		Main findings	Deductions
Communication		• ASD team collaborative behavioural patterns.	ASD teams spend most of their time on planning – results noted.
	Quality	The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of CMC increases.	Reasonable agreement that communication timeliness affects information exchange more as asynchronicity increases – pattern confirmed.
		Closed-loop communication allows more opportunities for information exchange and clarification which improves shared understanding.	Strong agreement that communication quality improves shared team understanding – pattern confirmed.
	Frequency	Communication frequency facilitates information sharing which may increase team cognition and team performance.	Strong agreement that information exchange facilitated by communication frequency increases team cognition and team performance – pattern confirmed.
		Possibility of a curvilinear relationship between frequency and team performance	Strong agreement that moderated information exchange is favourable to team performance and that curvilinear relationship is plausible – pattern confirmed.
Team performance		Communication and team cohesion seem to be the most acceptable means of measuring team performance, followed by team productivity, team member satisfaction, process satisfaction, and decision-related criteria.	Communicaton was ranked as the most important performance measure, followed closely by team effort and employee job satisfaction. Team productivity was confirmed as an important measure in the literature and from the questionnaire results. There seems to be consensus that team performance is a complex

Category	Main findings	Deductions
		conundrum of various team attributes as displayed by the almost relative equal importance of all team performance measures – pattern partially confirmed.

4.7. Conclusion

Insights regarding communication patterns and team performance of ASD teams were extracted from the literature. A quantitative survey was chosen to validate the insights. Data obtained from the structured questionnaire was analysed and interpreted to make deductions regarding the confirmation, partial confirmation, or rejection of the communication patterns and enablement of team performance.

The noteworthy deductions are summarised as follows:

- The diversity of roles and maturity of the respondents were thought to provide perceptive feedback.
- The preferred leadership style is servant leadership which is in line with the presence of a shift from person-centred to team-centred leadership. The leader-initiated allocation of responsibility to teams allows for increased information sharing.
- The medium of communication is a driver for team success and team success can be enhanced using the dialogue technique.
- Face-to-face communication increases team performance however the use of face-to-face communication is preferred only during the inception phase of the project.
- Collocated teams prefer using face-to-face communication whilst distributed teams prefer using email communication. Despite these preferences and regardless of team distribution and size, communication media that encourages closeness enhances communication.
- Understanding information, communication quality, and communication frequency contribute to common understanding.
- There is confirmation that project type influences the communication process.
- Transfer of knowledge within ASD teams increases team cognition.

- Increasing communication frequency, knowledge sharing, and feedback increase common awareness and team cohesion which increases trust.
- Email is the preferred communication medium for coordinating routine tasks.
- ASD teams spend their time mostly on planning activities.
- Communication timeliness affects information exchange more as asynchronicity increases.
- Communication quality improves shared team understanding.
- Moderate information exchange through communication frequency improves team cognition and team performance.
- Communication is the most important measure of team performance however various team attributes contribute to team performance.

The communication patterns and enablement of team performance provides insight into the current ASD team dynamic. Some of the previously known patterns were rejected but most patterns were found to be accurate. The proceeding chapter concludes the research and provides recommendations for future research.

5. Chapter 5: Conclusion

5.1. Purpose

This chapter summarises the intent of the research by delineating the research problem, outlines how the research problem domain was investigated through appraisal of the literature, states the chosen research design, and provides a brief explanation of the execution thereof, along with the analysis, results, and deductions based on the data gathered. Recommendations for the intended use of the results of this research are briefly discussed together with the research's limitations. The chapter concludes with suggestions for future research.

5.2. Summary of research methodology

Effective and efficient communication is necessary to achieve project success (Discenza and Forman, 2007; MacKellar, 2012; Kortum and Klunder, 2017). It has been proven that team performance affects project success. Furthermore, throughout the literature, there is perpetual emphasis on the importance of the communication-performance relationship (Henderson, 2004). Even with strong evidence that communication plays a vital role in determining team performance, there continues to be a lack of agreement concerning the inner workings of this relationship. Thus, defining and understanding the relationship between team communication and team performance in ASD teams formed the basis of this research.

The research was driven by the lack of holistic insight concerning the specific communication patterns that enable team performance. Hence, the research aimed to identify communication patterns and their enablement of team performance within ASD teams to begin understanding the research domain. To solve the research problem, the following questions required answering:

1. What are the known communication patterns within ASD teams?
2. How do the various identified communication patterns impact team performance?

To answer the research questions, a review of the current literature regarding communication patterns and team performance within ASD teams was conducted. The commencement of the

literature review found that the various ASD methods used by ASD teams are unique in their approach but are fundamentally governed by the values and principles outlined in the Agile Manifesto (Pikkarainen *et al.*, 2008). The values and principles were found to centre around communication and by examining the manifesto, certain team aspects of communication that enable the values and principles were identified. The identified team aspects formed the basis for the remainder of the literature review that resulted in the discovery of various eneralisable communication patterns – some with documented impact on team performance in ASD teams. The key insights from the literature are summarised in Figure *2*, Table 2, and Table 3 in Chapter 2. The team communication aspects identified were:

- Leadership.
- The medium of communication.
- Team processes (including team distribution, team characteristics, project type, team cognition, and trust).
- Measures of communication (including content, quality, and frequency).

The insights from the literature regarding the team communication aspects and performance required validation by ASD academics and practitioners. A descriptive research design was employed as the means of describing the behaviours of ASD teams (McCombes, 2019) with a quantitative survey being selected as the means of implementing the investigation. The research method employed was a structured questionnaire implemented using the web-based survey administrative app, SurveyMonkey. Data collected from the questionnaire was used to perform data analysis. The data analysis process initially involved a descriptive analysis of the data, followed by an analysis of the central tendency of the data, where warranted. The results were then interpreted, and deductions were made regarding the identified patterns. A summary of the deductions is presented next.

5.3. Results of the research and recommendations

The results from the survey were used to confirm, partially confirm, or reject the patterns regarding team communication aspects and performance identified from the literature. This was shown in Table 14. From the confirmation of the patterns, a rich description combining the confirmed patterns from Table 14 and the team performance model from the literature in Figure

2 was constructed. The patterns that were rejected were not included in this description. The final description of communication patterns and team performance in ASD teams is shown in Figure 20 as inputs, processes, and outputs of the team performance model. The description highlights key deductions regarding team communication aspects which can be successfully implemented in ASD teams to assist with improving team performance.

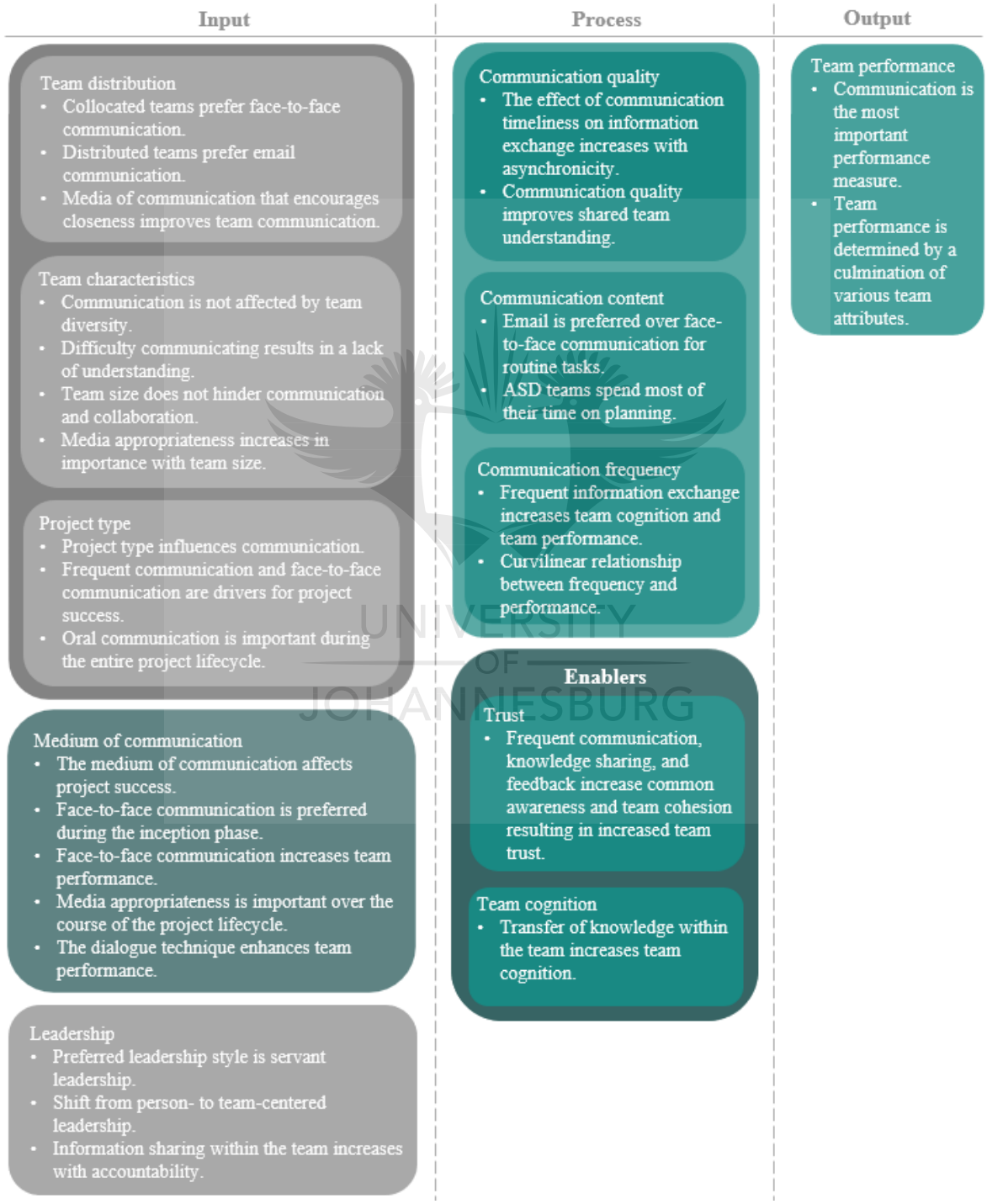

Figure 20: Rich description of communication patterns and team performance in ASD teams

The Agile Manifesto prescribes that the most efficient and effective method of conveying information to and within ASD teams is face-to-face communication which implies collocation of the team. At the time of data collection for the research, South Africa was under intermediate lockdown due to the COVID-19 pandemic, which meant that the working habits of ASD academics and practitioners differed from the norm. This is seen especially in the shift of the medium of communication preferred over the project lifecycle.

The description in Figure 20 forms a high-level guide that may prove useful to ASD teams. It provides insight into drivers for success in ASD teams which may prove valuable especially going forward as it depicts current working behaviours of ASD teams. The information is especially relevant with organisations rethinking their traditional working regime and considering more remote working. Furthermore, the research may be used as a starting point for future researchers in related detailed and confirmatory investigations surrounding the research topic.

5.4. Research limitations

Considerations during the research design process strove to contain the possible threats to the validity of the research study however, it is not always possible to eradicate all threats. Thus, the possible limitations of the study may include:

- The research study was an exploratory study describing associations between variables. The research design limited the ability to draw causal inferences due to the cross-sectional nature of the research study. However, it is noted that the research study aimed to only describe behaviours of ASD teams by identifying associations i.e. patterns regarding communication and team performance.
- The restriction of the literature review to predominantly journal articles.
- Relatively small sample size (i.e. 21 respondents) possibly due to the length of time the questionnaire was circulated for.
- Little control over the sampling technique i.e. snowball sampling.
- Sampling bias when using snowball sampling technique. Initial respondents tend to nominate people they know well and due to this, it is highly possible that the subjects share remarkably similar traits and behaviours.

- The reliability of the questionnaire could be unreliable. The Cronbach alpha reliability coefficient was calculated, and it was determined that the reliability of the data was good.
- Relying on the respondent's ability to accurately recall situations and volunteer information. This was partially mitigated by requesting respondents to provide information based on their recent projects and interactions within ASD teams.

5.5. Future research

This research intentionally sought to identify and describe behaviours at a high-level in the form of communication patterns and their enablement of team performance in ASD teams. Future research could focus on explanatory and longitudinal studies regarding this topic. This would aid in providing evidence regarding reasons for certain patterns occurring and confirming these patterns.

Certain patterns were either partially accepted or rejected which is considered a research gap that warrants further investigation.

The insights regarding ASD team performance are limited and not well defined. There is a lack of consensus on the most important team performance measures. A detailed study on this topic alone would prove beneficial to ASD teams. Furthermore, detailed guidance on how to improve communication within teams, which is linked to improvement in team performance, would be useful for ASD academics and practitoners. The results from this research would need to be taken further to begin to outline tangible ways in which improved communication can be achieved.

The Agile Manifesto is almost two decades old. There is no doubt that since its birth, the manifesto has changed the software development sphere. However, the question arises as to the appropriateness of the manifesto in such rapidly changing times. The manifesto prescribes face-to-face communication as one of its success factors. However, in the modern age, face-to-face communication is not always optimal or practical. As recently demonstrated by the COVID-19 pandemic, companies were forced to adapt to new ways of working that involved remote work, making face-to-face communication difficult. This research found that face-to-face communication was only preferred during the inception phase of the project, contrary to the

norm regarding the preferred medium of communication over the project life-cycle. This deviance alludes to an interesting question which warrants future studies – is the Agile Manifesto outdated? It is suggested that future studies focus on the relevance of the manifesto and whether the results of this research are seasonal or presents a shift in the behaviour of ASD academics and practitioners. If so, it might be time for a review and revision of the manifesto.

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Appendix A: High-level summary of the Agile Manifesto

Table 15: The Agile Manifesto values and principles (Kissflow, 2020; KnowledgeHut, 2019)

No.	Values
V1	Individuals and interactions over processes and tools.
V2	Working software over comprehensive documentation.
V3	Customer collaboration over contract negotiation.
V4	Responding to change over following a plan.
	Principles
P1	Focus on customer satisfaction by delivering early and continuous software.
P2	Accommodate changing requirements throughout the entire development process.
P3	Deliver working software frequently.
P4	Stakeholder (i.e. business people and developers) collaboration on a frequent (i.e. daily) basis throughout the entire development process.
P5	Create an environment wherein individuals feel supported, motivated, and trusted to do their job correctly.
P6	The most effective means of communication within a team is achieved via face-to-face interactions.
P7	Working software is the primary measure of progress.
P8	Agile processes promote sustainable development. The team should be able to maintain a constant development pace indefinitely.
P9	Self-organising teams with the correct skills and good design ensures agility.
P10	Focus on value-driven deliverables at each iteration through simplicity.
P11	Self-organising teams equipped with decision-making power and who take ownership and communicate frequently to share ideas achieve quality deliverables.
P12	Team reflection at regular intervals allows for improvements in the team's processes and behaviours.

Appendix B: Questionnaire

Cover letter:

I, Saieshni Thanthony, am undertaking a research study as part of my Masters in Engineering Management at the University of Johannesburg. I am investigating the communication patterns within agile software development teams and the impact on team performance which to date is still a topic which warrants further investigations. I would like to collect and understand your thoughts on the topic based on your experiences within agile software development teams. The answers from your questionnaire and those from others will be used as data for my research study report and to write academic articles. Furthermore, the findings can advise future detailed and longitudinal studies regarding this topic.

I would be grateful if you could answer the questionnaire. It should take approximately 30 minutes to complete. You will first be prompted to answer impersonal biographical questions in Section A followed by the questionnaire which comprises Section B and C.

Please click on the answer which most closely matches your view for each question. If you decide to participate in the study, you are still free to withdraw at any time without giving a reason. If you choose to withdraw, your answers will not be saved and cannot be accessed by any means. All information you provide will be treated in the strictest confidence and will be completely anonymous. Your identity cannot in any way be linked to your answers.

If you have any questions or would like further information, please do not hesitate to email me, Saieshni Thanthony, at saieshnithanthony@yahoo.com or my supervisors, under who I am completing the research – Prof. A.L. Marnewick and Prof. C Marnewick.

I hope that you will participate in the questionnaire and that you find the questionnaire interesting and relevant. When you have completed the questionnaire, you will be asked whether you wish to submit your responses.

Thank you for your help.

Name of researcher: Saieshni Thanthony, Masters in Engineering Management student
Supervisors: Prof. A.L. Marnewick and Prof. C. Marnewick
University: University of Johannesburg

SECTION A: BIOGRAPHICAL INFORMATION

1. Please indicate your primary role in agile software development project teams.

1.1.	Team manager	
1.2.	Team lead	
1.3.	Team member (e.g. developer, quality assurance, analyst)	
1.4.	Product owner	
1.5.	Domain expert (internal or external)	
1.6.	Stakeholders (e.g. users, managers of users, operations, support, investors)	
1.7.	On-site customer	
1.8.	Scrum master	
1.9.	Team coach	
1.10.	Project lead	
1.11.	Other (please specify)	

2. Please indicate your years of experience in agile software development projects.

2.1.	0-1 year	
2.2.	1-2 years	
2.3.	3-5 years	
2.4.	6-10 years	
2.5.	11-15 years	
2.6.	More than 15 years	

SECTION B: COMMUNICATION PATTERNS

Instructions:

Please answer the questions based on your experience in agile software development projects only.

1. Aspect: Leadership

Leadership is the ability to influence groups by maximising their combined efforts through communication for purposes of common goal achievement.

1.1. To what extent do you agree with the following statements:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1.1.1.	The team was led by the same team member throughout the project.					
1.1.2.	The team was led by different team members throughout the project depending on project requirements at the time.					
1.1.3.	There is a shift from person-centred leadership to team-centred leadership.					
1.1.4.	The leader set, translated, and executed the vision of the project with a focus on enabling team members to become better individuals that can serve the project and organisations' needs.					
1.1.5.	The leader demonstrated a command and control style of leadership.					
1.1.6.	I was trusted to make decisions regarding my work without consulting the team leader for every decision.					
1.1.7.	Taking responsibility for my work meant that I shared information regularly with the team members concerned.					

2. Aspect: Medium used for team communication

Complete the matrices in questions 2.1. and 2.2.

2.1. Rate your use of the following communication media over the entirety of the project.

		Never	Rarely	Sometimes	Often	Always
2.1.1.	Email					
2.1.2.	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)					
2.1.3.	Face-to-face					
2.1.4.	Audio conferencing (e.g. using Skype audio functionality only)					
2.1.5.	Video conferencing (e.g. using Skype audio and video functionality)					

2.2. Choose your preferred medium (only ONE) of communication per phase of the project. If you were not involved in a particular phase of the project, kindly indicate not applicable.

		Email	Instant messaging (e.g. using Skype	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Video conferencing (e.g. using Skype audio and video functionality)	Not applicable
2.2.1.	Inception: requirements discussion						
2.2.2.	Iteration: teams work to deliver working software based on requirements and feedback						
2.2.3.	Release: quality assurance testing, training, and documentation, release to production						
2.2.4.	Production: ongoing support of software						
2.2.5.	Retirement: end-of-life activities						

3. Aspect: Team distribution

Whilst working on agile software development projects, teams may be geographically dispersed (e.g. different offices, different countries) or located in the same physical location.

3.1. Rate your use of the following communication media over the entirety of the project for teams **located in the same physical location**.

		Never	Rarely	Sometimes	Often	Always
3.1.1.	Email					
3.1.2.	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)					
3.1.3.	Face-to-face					
3.1.4.	Audio conferencing (e.g. using Skype audio functionality only)					
3.1.5.	Video conferencing (e.g. using Skype audio and video functionality)					

3.2. Rate your use of the following communication media over the entirety of the project for teams that are **geographically dispersed**.

		Never	Rarely	Sometimes	Often	Always
3.2.1.	Email					

3.2.2.	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)					
3.2.3.	Face-to-face					
3.2.4.	Audio conferencing (e.g. using Skype audio functionality only)					
3.2.5.	Video conferencing (e.g. using Skype audio and video functionality)					

3.3. To what extent do you agree with the following statements:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
3.3.1.	Collocated teams communicate more efficiently than geographically dispersed teams.					
3.3.2.	Irrespective of team distribution, communication media that encourages closeness improves team communication.					

4. Aspect: Team characteristics

Diverse teams consist of teams with different cultures, languages, knowledge, backgrounds, and sizes present.

4.1. To what extent do you agree with the following:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
4.1.1.	Team diversity negatively affects the degree to which information is accurately conveyed.					
4.1.2.	Team diversity negatively affects the degree to which information is understood within your team.					
4.1.3.	Team diversity negatively affects how often you communicate with your team.					
4.1.4.	Difficulty in conveying information leads to a lacking of understanding within the project.					
4.1.5.	Difficulty in understanding information leads to a lacking of understanding within the project.					
4.1.6.	Difficulty in how often you communicate with your team members leads to a lack of understanding within the project.					
4.1.7.	Teams that are small in size hinder communication within the team.					

4.1.8.	Teams that are small in size hinder collaboration (working together to achieve a defined common goal/set of goals) within the team.					
4.1.9.	Selecting the correct communication media is important based on the team size.					

5. Aspect: Project type

Projects can be categorised in various ways and might be a combination of several types.

5.1. Which type of project best describes the current project you are involved in?

5.1.1.	Research and development: these projects include activities undertaken to innovate and introduce new products and services as an enhancement on an already existing one.	
5.1.2.	New product development: these projects introduce completely new products to the market.	
5.1.3.	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.	
5.1.4.	Projects for commercial release: these projects are developed to be sold for profit to an intended target market.	
5.1.5.	Internal projects: these projects involve the development of products and services to be used internally within an organisation.	
5.1.6.	Maintenance projects: these projects require ongoing administration of accepted and completed functionalities/features of products or services.	

5.2. To what extent do you agree with the following:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
5.2.1.	The project type influences the communication process.					
5.2.2.	The frequency (how often) of communication influences the success of the project.					
5.2.3.	Face-to-face communication influences the success of the project.					
5.2.4.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important for capturing project decisions for later reference.					
5.2.5.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important early in the project.					

5.2.6.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important during the project.					
5.2.7.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important towards the end of the project.					

6. Aspect: Shared team understanding

6.1. Shared team understanding encompasses the shared thought processes of all individuals in a team that facilitate the achievement of goals by acting as a coordinated unit.

To what extent do you agree with the following:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
6.1.1.	Transfer of knowledge from an individual to the team leads to increased shared team understanding.					

7. Aspect: Team trust

7.1. Trust within the team encompasses the willingness of individuals to rely on each other and take accountability for one's responsibilities to the team.

To what extent do you agree with the following:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
7.1.1.	Knowledge sharing and feedback lead to awareness of your team's activities and abilities.					
7.1.2.	Communicating more often leads to awareness of your team's activities and abilities.					
7.1.3.	Knowledge sharing and feedback lead to an enhanced team connection.					
7.1.4.	Communicating more often leads to an enhanced team connection.					
7.1.5.	Being aware of your team's activities and abilities leads to more trust within the team.					
7.1.6.	An enhanced team connection leads to more trust within the team.					

8. Aspect: Communication

8.1. Communication encompasses all processes used to exchange thoughts, messages, and information within the team.

To what extent do you agree with the following:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
8.1.1.	The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of communication media increases.					
8.1.2.	Shared team understanding increases as more information is exchanged (i.e. sending a message, understanding the message, and receiving feedback).					
8.1.3.	Shared team understanding increases as the opportunities for clarifying information increases.					
8.1.4.	Email is mainly used to coordinate the project's routine tasks.					
8.1.5.	Face-to-face communication is mainly used to coordinate the project's routine tasks.					

8.2. Rate your use of the following reasons for communicating over the entirety of the project.

		Never	Rarely	Sometimes	Often	Always
8.2.1.	For planning purposes					
8.2.2.	To contribute information/clarification					
8.2.3.	To seek information/clarification					
8.2.4.	To monitor and/or reflect on matters					
8.2.5.	Social interaction					

SECTION C: TEAM PERFORMANCE

1. Aspect: Team performance

1.1. To what extent do you agree with the following statements:

		Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Not applicable
1.1.1.	The choice as to which medium/media of communication to use for an agile software development project can affect the team's success.						
1.1.2.	Communicating via face-to-face communication results in increased team performance.						
1.1.3.	The dialogue technique can be used to improve team performance in teams using any type of communication media.						
1.1.4.	Transfer of knowledge from an individual to the team leads to increased shared team understanding which results in increased team performance.						
1.1.5.	More information is shared as the team communicates more often with one another which increases shared team understanding and thus team performance.						
1.1.6.	Too little information exchange can hinder team performance.						
1.1.7.	Too much information exchange can hinder team performance.						

1.2. Rate the importance of the measures of team performance.

		Not at all important	Low importance	Slightly important	Moderately important	Very important	Extremely important
1.2.1.	Communication						
1.2.2.	Team cohesion						
1.2.3.	Team productivity						
1.2.4.	Team member satisfaction						
1.2.5.	Satisfaction with team processes						
1.2.6.	Decision process satisfaction						
1.2.7.	Coordination within the team						
1.2.8.	Mutual support within the team						
1.2.9.	Team effort						
1.2.10.	Conflict management within the team						
1.2.11.	Team creativity						
1.2.12.	Team interaction quality						
1.2.13.	Employee job satisfaction						

Appendix C: Questionnaire responses

SECTION A: BIOGRAPHICAL INFORMATION

Question 1 and 2:

Respondent	Question 1	Question 2
1	Other (please specify)	6-10 years
2	Team member (e.g. developer, quality assurance, analyst)	1-2 years
3	Team member (e.g. developer, quality assurance, analyst)	3-5 years
4	Project lead	6-10 years
5	Team lead	6-10 years
6	Team manager	3-5 years
7	Team coach	3-5 years
8	Product owner	6-10 years
9	Team member (e.g. developer, quality assurance, analyst)	0-1 year
10	Team lead	3-5 years
11	Team lead	6-10 years
12	Team member (e.g. developer, quality assurance, analyst)	1-2 years
13	Other (please specify)	More than 15 years
14	Team manager	6-10 years
15	Product owner	3-5 years
16	Team member (e.g. developer, quality assurance, analyst)	3-5 years
17	Team member (e.g. developer, quality assurance, analyst)	1-2 years
18	Other (please specify)	More than 15 years
19	Team lead	6-10 years
20	Team member (e.g. developer, quality assurance, analyst)	6-10 years
21	Team manager	1-2 years

SECTION B: COMMUNICATION PATTERNS

Question 1.1:

Respondent	The team was led by the same team member throughout the project.	The team was led by different team members throughout the project depending on project requirements at the time.	There is a shift from person-centered leadership to team-centered leadership.	The leader set, translated, and executed the vision of the project with a focus on enabling team members to become better individuals that can serve the project and organisations' needs.	The leader demonstrated a command and control style of leadership.	I was trusted to make decisions regarding my work without consulting the team leader for every decision.	Taking responsibility for my work meant that I shared information regularly with the team members concerned.
1	Agree	Strongly agree	Strongly agree	Agree	Agree	Strongly agree	Strongly agree
2	Disagree	Strongly agree	Agree	Agree	Agree	Strongly agree	Strongly agree
3	Agree	Agree	Agree	Agree	Neither agree nor disagree	Agree	Strongly agree
4	Agree	Agree	Neither agree nor disagree	Agree	Agree	Agree	Agree
5	Agree	Disagree	Neither agree nor disagree	Agree	Neither agree nor disagree	Strongly agree	Agree
6	Agree	Disagree	Disagree	Strongly agree	Disagree	Strongly agree	Agree
7	Agree	Disagree	Disagree	Neither agree nor disagree	Neither agree nor disagree	Neither agree nor disagree	Neither agree nor disagree
8	Strongly agree	Agree	Agree	Agree	Disagree	Agree	Agree
9	Agree	Neither agree nor disagree	Agree	Agree	Strongly agree	Strongly agree	Agree
10	Strongly agree	Disagree	Agree	Agree	Agree	Agree	Agree
11	Neither agree nor disagree	Agree	Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
12	Strongly agree	Strongly disagree	Agree	Agree	Neither agree nor disagree	Strongly agree	Agree
13	Strongly agree	Neither agree nor disagree	Agree	Agree	Agree	Neither agree nor disagree	Strongly agree

Respondent	The team was led by the same team member throughout the project.	The team was led by different team members throughout the project depending on project requirements at the time.	There is a shift from person-centered leadership to team-centered leadership.	The leader set, translated, and executed the vision of the project with a focus on enabling team members to become better individuals that can serve the project and organisations' needs.	The leader demonstrated a command and control style of leadership.	I was trusted to make decisions regarding my work without consulting the team leader for every decision.	Taking responsibility for my work meant that I shared information regularly with the team members concerned.
14	Agree	Strongly disagree	Neither agree nor disagree	Neither agree nor disagree	Strongly disagree	Agree	Agree
15	Neither agree nor disagree	Agree	Agree	Agree	Neither agree nor disagree	Agree	Strongly agree
16	Strongly agree	Strongly disagree	Agree	Neither agree nor disagree	Neither agree nor disagree	Agree	Agree
17	Strongly agree	Disagree	Agree	Agree	Strongly disagree	Agree	Agree
18	Neither agree nor disagree	Strongly agree	Agree	Strongly agree	Neither agree nor disagree	Agree	Strongly agree
19	Agree	Agree	Neither agree nor disagree	Agree	Neither agree nor disagree	Agree	Strongly agree
20	Strongly agree	Neither agree nor disagree	Agree	Agree	Disagree	Strongly agree	Strongly agree
21	Neither agree nor disagree	Disagree	Disagree	Disagree	Neither agree nor disagree	Neither agree nor disagree	Disagree

Question 2.1:

Respondent	Email	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Video conferencing (e.g. using Skype audio and video functionality)
1	Always	Always	Often	Always	Sometimes
2	Often	Often	Often	Often	Often
3	Sometimes	Always	Often	Often	Often
4	Often	Often	Often	Often	Often
5	Often	Always	Sometimes	Often	Always
6	Always	Often	Often	Often	Rarely
7	Often	Often	Often	Often	Often
8	Often	Rarely	Never	Rarely	Always
9	Often	Often	Rarely	Rarely	Always
10	Always	Often	Often	Often	Rarely
11	Always	Often	Always	Often	Often
12	Often	Sometimes	Often	Never	Never
13	Often	Always	Sometimes	Often	Rarely
14	Often	Always	Always	Always	Always
15	Often	Always	Sometimes	Rarely	Often
16	Often	Always	Always	Never	Often
17	Often	Often	Sometimes	Often	Often
18	Often	Often	Sometimes	Often	Sometimes
19	Often	Often	Often	Always	Often
20	Always	Always	Always	Often	Often
21	Never	Sometimes	Sometimes	Sometimes	Sometimes

Question 2.2:

Respondent	Inception: requirements discussion	Iteration: teams work to deliver working software based on requirements and feedback	Release: quality assurance testing, training, and documentation, release to production)	Production: ongoing support of software	Retirement: end-of-life activities
1	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Audio conferencing (e.g. using Skype audio functionality only)	Email
2	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)
3	Face-to-face	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Not applicable	Email
4	Face-to-face	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Audio conferencing (e.g. using Skype audio functionality only)	Email	Email
5	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)	Email	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Video conferencing (e.g. using Skype audio and video functionality)
6	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Not applicable
7	Face-to-face	Face-to-face	Face-to-face	Face-to-face	Face-to-face
8	Video conferencing (e.g. using Skype audio and video functionality)	Video conferencing (e.g. using Skype audio and video functionality)	Not applicable	Not applicable	Video conferencing (e.g. using Skype audio and video functionality)
9	Video conferencing (e.g. using Skype audio and video functionality)	Video conferencing (e.g. using Skype audio and video functionality)	Video conferencing (e.g. using Skype audio and video functionality)	Email	Video conferencing (e.g. using Skype audio and video functionality)
10	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Video conferencing (e.g. using Skype audio and video functionality)	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)
11	Face-to-face	Email	Email	Email	Face-to-face

Question 2.2 continued:

Respondent	Inception: requirements discussion	Iteration: teams work to deliver working software based on requirements and feedback	Release: quality assurance testing, training, and documentation, release to production)	Production: ongoing support of software	Retirement: end-of-life activities
12	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)	Video conferencing (e.g. using Skype audio and video functionality)	Audio conferencing (e.g. using Skype audio functionality only)	Face-to-face
13	Email	Email	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Email
14	Face-to-face	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)
15	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)	Video conferencing (e.g. using Skype audio and video functionality)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Email
16	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)	Email
17	Face-to-face	Face-to-face	Video conferencing (e.g. using Skype audio and video functionality)	Video conferencing (e.g. using Skype audio and video functionality)	Email
18	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)	Audio conferencing (e.g. using Skype audio functionality only)
19	Video conferencing (e.g. using Skype audio and video functionality)	Audio conferencing (e.g. using Skype audio functionality only)	Email	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Email
20	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Email	Face-to-face
21	Face-to-face	Face-to-face	Face-to-face	Face-to-face	Face-to-face

Question 3.1:

Respondent	Email	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Video conferencing (e.g. using Skype audio and video functionality)
1	Often	Often	Always	Never	Never
2	Often	Often	Often	Often	Rarely
3	Sometimes	Sometimes	Always	Rarely	Rarely
4	Sometimes	Often	Always	Sometimes	Sometimes
5	Sometimes	Sometimes	Always	Rarely	Rarely
6	Always	Sometimes	Often	Never	Never
7	Often	Often	Often	Often	Rarely
8	Often	Often	Often	Never	Rarely
9	Often	Sometimes	Often	Rarely	Always
10	Always	Often	Often	Often	Never
11	Always	Sometimes	Often	Sometimes	Sometimes
12	Rarely	Rarely	Often	Never	Never
13	Often	Always	Often	Often	Rarely
14	Never	Always	Always	Rarely	Rarely
15	Sometimes	Often	Often	Never	Never
16	Often	Often	Always	Never	Often
17	Often	Often	Often	Sometimes	Rarely
18	Often	Often	Sometimes	Often	Rarely
19	Sometimes	Often	Often	Rarely	Rarely
20	Often	Always	Always	Rarely	Rarely
21	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes

Question 3.2:

Respondent	Email	Instant messaging (e.g. using Skype messenger, WhatsApp etc.)	Face-to-face	Audio conferencing (e.g. using Skype audio functionality only)	Video conferencing (e.g. using Skype audio and video functionality)
1	Always	Always	Never	Always	Sometimes
2	Often	Often	Never	Often	Never
3	Often	Often	Rarely	Often	Often
4	Often	Always	Always	Always	Often
5	Often	Often	Rarely	Often	Often
6	Often	Always	Never	Often	Rarely
7	Often	Often	Sometimes	Often	Often
8	Often	Rarely	Never	Never	Often
9	Often	Often	Rarely	Rarely	Always
10	Always	Rarely	Rarely	Sometimes	Never
11	Always	Sometimes	Rarely	Sometimes	Sometimes
12	Often	Often	Rarely	Sometimes	Often
13	Often	Always	Never	Always	Rarely
14	Rarely	Always	Rarely	Always	Sometimes
15	Often	Often	Rarely	Never	Often
16	Often	Always	Rarely	Never	Always
17	Often	Often	Rarely	Often	Rarely
18	Often	Often	Sometimes	Often	Sometimes
19	Often	Often	Rarely	Always	Often
20	Always	Always	Rarely	Often	Often
21	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes

Question 3.3:

Respondent	Collocated teams communicate more efficiently than geographically dispersed teams.	Irrespective of team distribution, communication media that encourages closeness improves team communication.
1	Strongly agree	Agree
2	Agree	Strongly agree
3	Agree	Agree
4	Neither agree nor disagree	Agree
5	Agree	Strongly agree
6	Neither agree nor disagree	Strongly agree
7	Strongly agree	Agree
8	Neither agree nor disagree	Agree
9	Neither agree nor disagree	Strongly agree
10	Agree	Agree
11	Disagree	Agree
12	Neither agree nor disagree	Agree
13	Disagree	Strongly agree
14	Agree	Agree
15	Strongly agree	Agree
16	Disagree	Agree
17	Disagree	Strongly agree
18	Strongly disagree	Strongly agree
19	Disagree	Strongly agree
20	Strongly agree	Strongly agree
21	Neither agree nor disagree	Neither agree nor disagree

Question 4.1:

Respondent	Team diversity negatively affects the degree to which information is accurately conveyed.	Team diversity negatively affects the degree to which information is understood within your team.	Team diversity negatively affects how often you communicate with your team.	Difficulty in conveying information leads to a lack of understanding within the project.	Difficulty in understanding information leads to a lack of understanding within the project.
1	Strongly agree	Strongly agree	Strongly disagree	Strongly agree	Agree
2	Disagree	Disagree	Disagree	Agree	Agree
3	Strongly disagree	Neither agree nor disagree	Strongly disagree	Strongly agree	Strongly agree
4	Neither agree nor disagree	Neither agree nor disagree	Agree	Agree	Agree
5	Agree	Neither agree nor disagree	Neither agree nor disagree	Agree	Agree
6	Neither agree nor disagree	Agree	Agree	Agree	Strongly agree
7	Neither agree nor disagree	Neither agree nor disagree	Neither agree nor disagree	Neither agree nor disagree	Agree
8	Agree	Agree	Disagree	Agree	Agree
9	Disagree	Disagree	Disagree	Agree	Agree
10	Disagree	Disagree	Disagree	Agree	Agree
11	Disagree	Disagree	Strongly disagree	Strongly agree	Strongly agree
12	Agree	Strongly agree	Agree	Strongly agree	Strongly agree
13	Disagree	Neither agree nor disagree	Disagree	Agree	Agree
14	Agree	Agree	Disagree	Neither agree nor disagree	Agree
15	Neither agree nor disagree	Agree	Disagree	Agree	Agree
16	Neither agree nor disagree	Neither agree nor disagree	Agree	Strongly agree	Agree
17	Disagree	Disagree	Disagree	Strongly agree	Strongly agree
18	Neither agree nor disagree	Neither agree nor disagree	Disagree	Agree	Agree

Respondent	Team diversity negatively affects the degree to which information is accurately conveyed.	Team diversity negatively affects the degree to which information is understood within your team.	Team diversity negatively affects how often you communicate with your team.	Difficulty in conveying information leads to a lack of understanding within the project.	Difficulty in understanding information leads to a lack of understanding within the project.
19	Strongly disagree	Disagree	Strongly disagree	Strongly agree	Strongly agree
20	Disagree	Disagree	Strongly disagree	Strongly agree	Strongly agree
21	Disagree	Neither agree nor disagree	Neither agree nor disagree	Agree	Strongly agree

Question 4.1 continued:

Respondent	Difficulty in how often you communicate with your team members leads to a lack of understanding within the project.	Teams that are small in size hinder communication within the team.	Teams that are small in size hinder collaboration (working together to achieve a defined common goal/set of goals) within the team.	Selecting the correct communication media is important based on the team size.
1	Strongly agree	Strongly disagree	Strongly disagree	Agree
2	Agree	Disagree	Disagree	Strongly agree
3	Strongly agree	Disagree	Disagree	Strongly agree
4	Agree	Neither agree nor disagree	Neither agree nor disagree	Agree
5	Neither agree nor disagree	Disagree	Disagree	Strongly agree
6	Agree	Disagree	Disagree	Agree
7	Agree	Strongly disagree	Strongly disagree	Agree
8	Agree	Disagree	Disagree	Agree
9	Agree	Strongly disagree	Disagree	Strongly agree
10	Strongly agree	Strongly disagree	Strongly disagree	Neither agree nor disagree
11	Strongly agree	Strongly disagree	Strongly disagree	Agree

Respondent	Difficulty in how often you communicate with your team members leads to a lack of understanding within the project.	Teams that are small in size hinder communication within the team.	Teams that are small in size hinder collaboration (working together to achieve a defined common goal/set of goals) within the team.	Selecting the correct communication media is important based on the team size.
12	Agree	Disagree	Disagree	Strongly agree
13	Agree	Disagree	Disagree	Agree
14	Agree	Disagree	Disagree	Neither agree nor disagree
15	Agree	Strongly disagree	Disagree	Agree
16	Strongly agree	Strongly disagree	Strongly disagree	Strongly agree
17	Agree	Strongly disagree	Strongly disagree	Agree
18	Strongly agree	Strongly disagree	Strongly disagree	Disagree
19	Strongly agree	Strongly disagree	Strongly disagree	Agree
20	Agree	Strongly disagree	Strongly disagree	Agree
21	Agree	Neither agree nor disagree	Disagree	Strongly disagree

Question 5.1:

Respondent	Response
1	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
2	Research and development: these projects include activities undertaken to innovate and introduce new products and services as an enhancement on an already existing one
3	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
4	Projects for commercial release: these projects are developed to be sold for profit to an intended target market.
5	Internal projects: these projects involve the development of products and services to be used internally within an organisation.
6	Maintenance projects: these projects require ongoing administration of accepted and completed functionalities/features of products or services.
7	Internal projects: these projects involve the development of products and services to be used internally within an organisation.
8	Internal projects: these projects involve the development of products and services to be used internally within an organisation.
9	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
10	New product development: these projects introduce completely new products to the market.
11	Projects for commercial release: these projects are developed to be sold for profit to an intended target market.
12	Maintenance projects: these projects require ongoing administration of accepted and completed functionalities/features of products or services.
13	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
14	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
15	New product development: these projects introduce completely new products to the market.
16	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
17	Internal projects: these projects involve the development of products and services to be used internally within an organisation.
18	Projects for commercial release: these projects are developed to be sold for profit to an intended target market.
19	Mission-critical projects: these projects are extremely vital to the success of the organisation or business.
20	New product development: these projects introduce completely new products to the market.
21	New product development: these projects introduce completely new products to the market.

Question 5.2:

Respondent	The project type influences the communication process.	The frequency (how often) of communication influences the success of the project.	Face-to-face communication influences the success of the project.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important for capturing project decisions for later reference.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important early in the project.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important during the project.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important towards the end of the project.
1	Agree	Strongly agree	Disagree	Agree	Agree	Agree	Agree
2	Disagree	Strongly agree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree
3	Agree	Disagree	Neither agree nor disagree	Neither agree nor disagree	Disagree	Strongly agree	Strongly agree
4	Agree	Agree	Agree	Agree	Agree	Agree	Agree
5	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree	Agree	Neither agree nor disagree	Neither agree nor disagree
6	Agree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
7	Neither agree nor disagree	Agree	Agree	Agree	Agree	Agree	Agree
8	Disagree	Agree	Agree	Agree	Agree	Agree	Agree
9	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
10	Agree	Agree	Agree	Agree	Agree	Agree	Agree
11	Strongly agree	Agree	Neither agree nor disagree	Agree	Agree	Agree	Agree
12	Agree	Agree	Neither agree nor disagree	Strongly agree	Agree	Agree	Agree
13	Disagree	Agree	Disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
14	Neither agree nor disagree	Agree	Agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree

Respondent	The project type influences the communication process.	The frequency (how often) of communication influences the success of the project.	Face-to-face communication influences the success of the project.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important for capturing project decisions for later reference.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important early in the project.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important during the project.	Oral communication (includes both face-to-face and any form of virtual/online verbal communication) is important towards the end of the project.
15	Neither agree nor disagree	Strongly agree	Agree	Agree	Agree	Agree	Neither agree nor disagree
16	Agree	Agree	Strongly agree	Strongly disagree	Strongly agree	Strongly agree	Strongly agree
17	Neither agree nor disagree	Agree	Agree	Agree	Strongly agree	Agree	Disagree
18	Agree	Agree	Disagree	Strongly agree	Strongly agree	Agree	Agree
19	Agree	Neither agree nor disagree	Neither agree nor disagree	Agree	Strongly agree	Agree	Agree
20	Disagree	Neither agree nor disagree	Neither agree nor disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
21	Disagree	Neither agree nor disagree	Agree	Strongly agree	Agree	Neither agree nor disagree	Disagree

Question 6.1:

Respondent	Transfer of knowledge from an individual to the team leads to increased shared team understanding.
1	Strongly agree
2	Strongly agree
3	Strongly agree
4	Agree
5	Agree
6	Strongly agree
7	Agree
8	Agree
9	Strongly agree
10	Strongly agree
11	Strongly agree
12	Strongly agree
13	Strongly agree
14	Strongly agree
15	Agree
16	Strongly agree
17	Strongly agree
18	Strongly agree
19	Strongly agree
20	Strongly agree
21	Disagree

Question 7.1:

Respondent	Knowledge sharing and feedback lead to awareness of your team's activities and abilities.	Communicating more often leads to awareness of your team's activities and abilities.	Knowledge sharing and feedback lead to an enhanced team connection.	Communicating more often leads to an enhanced team connection.	Being aware of your team's activities and abilities leads to more trust within the team.	An enhanced team connection leads to more trust within the team.
1	Strongly agree	Agree	Agree	Strongly agree	Agree	Strongly agree
2	Agree	Strongly agree	Agree	Strongly agree	Agree	Agree
3	Strongly agree	Strongly agree	Agree	Agree	Agree	Agree
4	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
5	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
6	Agree	Agree	Agree	Strongly agree	Strongly agree	Agree
7	Agree	Agree	Agree	Agree	Agree	Agree
8	Agree	Agree	Agree	Agree	Agree	Agree
9	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
10	Agree	Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
11	Strongly agree	Strongly agree	Strongly agree	Agree	Neither agree nor disagree	Strongly agree
12	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree
13	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
14	Neither agree nor disagree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
15	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
16	Strongly agree	Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
17	Strongly agree	Agree	Agree	Agree	Strongly agree	Strongly agree
18	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree	Strongly agree
19	Strongly agree	Agree	Strongly agree	Agree	Strongly agree	Strongly agree
20	Agree	Agree	Strongly agree	Agree	Strongly agree	Strongly agree
21	Disagree	Neither agree nor disagree	Agree	Strongly agree	Agree	Neither agree nor disagree

Question 8.1:

Respondent	The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of communication media increases.	Shared team understanding increases as more information is exchanged (i.e. sending a message, understanding the message, and receiving feedback).	Shared team understanding increases as the opportunities for clarifying information increases.	Email is mainly used to coordinate the project's routine tasks.	Face-to-face communication is mainly used to coordinate the project's routine tasks.
1	Agree	Agree	Strongly agree	Strongly agree	Agree
2	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Disagree
3	Agree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
4	Agree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
5	Agree	Agree	Agree	Disagree	Disagree
6	Neither agree nor disagree	Agree	Agree	Disagree	Agree
7	Agree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
8	Neither agree nor disagree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
9	Neither agree nor disagree	Strongly agree	Strongly agree	Agree	Agree
10	Neither agree nor disagree	Agree	Agree	Agree	Neither agree nor disagree
11	Agree	Strongly agree	Agree	Strongly agree	Neither agree nor disagree
12	Agree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree
13	Agree	Strongly agree	Strongly agree	Agree	Disagree
14	Agree	Agree	Agree	Neither agree nor disagree	Neither agree nor disagree

Respondent	The effect of communication timeliness on exchanging information seems to increase as the asynchronicity of communication media increases.	Shared team understanding increases as more information is exchanged (i.e. sending a message, understanding the message, and receiving feedback).	Shared team understanding increases as the opportunities for clarifying information increases.	Email is mainly used to coordinate the project's routine tasks.	Face-to-face communication is mainly used to coordinate the project's routine tasks.
15	Neither agree nor disagree	Strongly agree	Strongly agree	Disagree	Disagree
16	Agree	Strongly agree	Agree	Agree	Neither agree nor disagree
17	Disagree	Agree	Strongly agree	Disagree	Agree
18	Strongly agree	Strongly agree	Strongly agree	Agree	Disagree
19	Neither agree nor disagree	Agree	Strongly agree	Agree	Disagree
20	Strongly agree	Strongly agree	Strongly agree	Agree	Neither agree nor disagree
21	Disagree	Neither agree nor disagree	Agree	Strongly agree	Agree

Question 8.2:

Respondent	For planning purposes	To contribute information/clarification	To seek information/clarification	To monitor and/or reflect on matters	Social interaction
1	Always	Always	Always	Often	Rarely
2	Often	Often	Often	Often	Rarely
3	Always	Always	Always	Always	Often
4	Always	Sometimes	Sometimes	Sometimes	Often
5	Always	Often	Often	Sometimes	Sometimes
6	Always	Always	Always	Sometimes	Rarely
7	Sometimes	Sometimes	Sometimes	Sometimes	Sometimes
8	Often	Often	Often	Often	Often
9	Always	Often	Sometimes	Sometimes	Often
10	Always	Sometimes	Often	Often	Always
11	Always	Always	Always	Always	Sometimes
12	Often	Often	Often	Often	Rarely
13	Always	Always	Always	Always	Often
14	Always	Always	Always	Always	Always
15	Always	Often	Often	Often	Often
16	Always	Often	Often	Sometimes	Sometimes
17	Always	Sometimes	Often	Sometimes	Sometimes
18	Always	Always	Always	Always	Rarely
19	Always	Often	Always	Often	Sometimes
20	Always	Always	Always	Always	Always
21	Rarely	Sometimes	Often	Always	Often

SECTION C: TEAM PERFORMANCE

Question 1.1:

Respondent	The choice as to which medium/media of communication to use for an agile software development project can affect the team's success.	Communicating via face-to-face communication results in increased team performance.	The dialogue technique can be used to improve team performance in teams using any type of communication media.	Transfer of knowledge from an individual to the team leads to increased shared team understanding which results in increased team performance.	More information is shared as the team communicates more often with one another which increases shared team understanding and thus team performance.
1	Not applicable	Strongly agree	Strongly agree	Strongly agree	Not applicable
2	Agree	Agree	Agree	Agree	Agree
3	Strongly agree	Neither agree nor disagree	Agree	Strongly agree	Agree
4	Agree	Agree	Not applicable	Agree	Agree
5	Agree	Strongly agree	Not applicable	Strongly agree	Agree
6	Strongly agree	Agree	Agree	Agree	Agree
7	Agree	Agree	Agree	Agree	Agree
8	Agree	Agree	Agree	Agree	Agree
9	Strongly agree	Strongly agree	Agree	Strongly agree	Strongly agree
10	Agree	Neither agree nor disagree	Neither agree nor disagree	Strongly agree	Agree
11	Agree	Agree	Agree	Not applicable	Strongly agree
12	Strongly agree	Agree	Agree	Strongly agree	Strongly agree
13	Agree	Disagree	Agree	Not applicable	Not applicable
14	Agree	Agree	Neither agree nor disagree	Agree	Agree
15	Strongly agree	Strongly agree	Neither agree nor disagree	Agree	Strongly agree
16	Strongly agree	Agree	Neither agree nor disagree	Agree	Agree
17	Neither agree nor disagree	Disagree	Agree	Agree	Agree

Respondent	The choice as to which medium/media of communication to use for an agile software development project can affect the team's success.	Communicating via face-to-face communication results in increased team performance.	The dialogue technique can be used to improve team performance in teams using any type of communication media.	Transfer of knowledge from an individual to the team leads to increased shared team understanding which results in increased team performance.	More information is shared as the team communicates more often with one another which increases shared team understanding and thus team performance.
18	Agree	Disagree	Agree	Strongly agree	Strongly agree
19	Agree	Neither agree nor disagree	Strongly agree	Strongly agree	Not applicable
20	Agree	Agree	Agree	Agree	Agree
21	Disagree	Neither agree nor disagree	Agree	Strongly agree	Not applicable

Question 1.1. continued:

Respondent	Too little information exchange can hinder team performance.	Too much information exchange can hinder team performance.
1	Strongly agree	Not applicable
2	Strongly agree	Agree
3	Strongly agree	Agree
4	Agree	Agree
5	Agree	Disagree
6	Agree	Agree
7	Agree	Agree
8	Agree	Neither agree nor disagree
9	Strongly agree	Neither agree nor disagree

Respondent	Too little information exchange can hinder team performance.	Too much information exchange can hinder team performance.
10	Strongly agree	Strongly agree
11	Not applicable	Strongly disagree
12	Strongly disagree	Not applicable
13	Strongly agree	Strongly agree
14	Strongly agree	Agree
15	Strongly agree	Agree
16	Strongly agree	Agree
17	Strongly agree	Agree
18	Strongly agree	Neither agree nor disagree
19	Strongly disagree	Disagree
20	Strongly agree	Agree
21	Strongly agree	Agree

Question 1.2:

Respondent	Communication	Team cohesion	Team productivity	Team member satisfaction	Satisfaction with team processes
1	Extremely important	Very important	Very important	Extremely important	Very important
2	Very important	Very important	Very important	Very important	Moderately important
3	Extremely important	Very important	Very important	Moderately important	Very important
4	Extremely important	Very important	Very important	Extremely important	Very important
5	Very important	Very important	Very important	Very important	Moderately important
6	Very important	Very important	Moderately important	Very important	Moderately important
7	Very important	Very important	Very important	Very important	Very important
8	Very important	Very important	Very important	Moderately important	Moderately important
9	Extremely important	Extremely important	Extremely important	Moderately important	Moderately important
10	Very important	Extremely important	Very important	Very important	Very important
11	Extremely important	Moderately important	Very important	Very important	Moderately important
12	Extremely important	Very important	Very important	Very important	Very important
13	Extremely important	Extremely important	Extremely important	Extremely important	Very important
14	Extremely important	Very important	Very important	Moderately important	Moderately important
15	Extremely important	Extremely important	Very important	Moderately important	Moderately important
16	Very important	Moderately important	Very important	Extremely important	Very important
17	Very important	Moderately important	Extremely important	Extremely important	Slightly important
18	Extremely important	Moderately important	Very important	Moderately important	Slightly important
19	Extremely important	Extremely important	Very important	Very important	Moderately important
20	Very important	Very important	Very important	Very important	Moderately important
21	Low importance	Slightly important	Moderately important	Very important	Extremely important

Question 1.2 continued:

Respondent	Decision process satisfaction	Coordination within the team	Mutual support within the team	Team effort	Conflict management within the team
1	Extremely important	Extremely important	Extremely important	Very important	Very important
2	Moderately important	Moderately important	Extremely important	Extremely important	Very important
3	Moderately important	Extremely important	Very important	Extremely important	Extremely important
4	Very important	Extremely important	Extremely important	Extremely important	Very important
5	Very important	Very important	Very important	Extremely important	Moderately important
6	Slightly important	Moderately important	Very important	Very important	Moderately important
7	Very important	Very important	Very important	Very important	Very important
8	Very important	Moderately important	Very important	Very important	Very important
9	Slightly important	Very important	Very important	Extremely important	Extremely important
10	Very important	Very important	Extremely important	Extremely important	Very important
11	Moderately important	Extremely important	Extremely important	Extremely important	Very important
12	Very important	Very important	Very important	Extremely important	Extremely important
13	Very important	Very important	Extremely important	Extremely important	Very important
14	Moderately important	Very important	Very important	Very important	Very important
15	Very important	Moderately important	Moderately important	Very important	Very important
16	Moderately important	Very important	Extremely important	Moderately important	Extremely important
17	Slightly important	Very important	Moderately important	Very important	Extremely important
18	Slightly important	Very important	Moderately important	Extremely important	Slightly important
19	Very important	Extremely important	Extremely important	Very important	Very important
20	Very important	Very important	Very important	Very important	Very important
21	Very important	Moderately important	Slightly important	Low importance	Not at all important

Question 1.2 continued:

Respondent	Team creativity	Team interaction quality	Employee job satisfaction
1	Very important	Moderately important	Extremely important
2	Very important	Very important	Moderately important
3	Moderately important	Very important	Moderately important
4	Very important	Very important	Extremely important
5	Very important	Very important	Very important
6	Slightly important	Very important	Very important
7	Moderately important	Very important	Very important
8	Very important	Very important	Very important
9	Extremely important	Very important	Extremely important
10	Very important	Very important	Very important
11	Moderately important	Moderately important	Very important
12	Extremely important	Extremely important	Extremely important
13	Very important	Extremely important	Extremely important
14	Very important	Very important	Very important
15	Moderately important	Very important	Very important
16	Very important	Slightly important	Extremely important
17	Very important	Very important	Extremely important
18	Moderately important	Slightly important	Moderately important
19	Moderately important	Very important	Very important
20	Very important	Very important	Very important
21	Low importance	Slightly important	Moderately important